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Analysis of Mission-Based Scenarios for Training Soldiers and Small Unit Leaders in Virtual Environments

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14. ABSTRACT *(Maximum 200 words)*:

This report describes a multi-tiered process for generating a set of high payoff tasks that can be cost effectively represented in virtual environments. The tasks were used to guide the development of small unit (squad/team) dismounted Infantry training scenarios which were evaluated at the Dismounted Battlespace Battlelab (DBBL) Land Warrior Test Bed. Scenarios were based on five major tasks, Assault, Move Tactically, Enter Building and Clear a Room, Reconnoiter Area, and React to Contact. Soldiers, working as teams or part of a squad, executed all task-based scenarios through the use of individual combatant simulators. Soldiers indicated that simulations improved their real-world performance on similar tasks. Overall, the simulators were seen as effective for small unit training, e.g., team coordination, communication, decision making. The scenarios which provided the most training value integrated soldiers with computer generated forces to provide live force-on-force capability. The research showed the potential training value of dismounted Infantry simulation technologies for soldier and small unit training, particularly, cognitive-based activities. Subsequent research will focus on the use of this technology to enhance the decision-making skills of soldiers and small unit leaders.

15. SUBJECT TERMS

Virtual environments, Individual combatant simulators, Dismounted Infantry simulation, Soldier and small unit leader training

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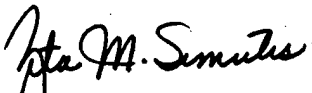
FOREWORD

This report describes selected aspects of the first year work effort under the Science and Technology Objective (STO) entitled *Virtual Environments for Dismounted Soldier Simulation, Training, and Mission Rehearsal*. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Infantry Forces Research Unit performed this research in collaboration with the ARI Simulation Systems Research Unit, the U.S. Army Simulation, Training, and Instrumentation Command, and the U.S. Army Research Laboratory. The primary objective of the STO was to address selected technological and training issues related to high fidelity dismounted soldier simulation.

This report describes a multi-tiered process for identifying potential high payoff tasks for training small unit dismounted Infantry soldiers in simulated urban operations. The tasks were used to guide the development of small unit (squad/team) dismounted Infantry training scenarios which were evaluated at the Dismounted Battlespace Battle Lab (DBBL) Land Warrior Test Bed, Fort Benning, Georgia. This research identifies training and scenario-related factors that can improve the utilization of virtual environments for training soldiers and small unit leaders. Task-based training simulation scenarios enable soldiers to rehearse a variety of battlefield situations at reduced cost to the unit in either training time or actual expense. Extensive exposure to simulations allows soldiers to familiarize themselves with specific aspects of selected tasks. The identified high payoff tasks, combined into scenarios, can improve training for dismounted soldiers and small unit leaders and leverage the potential of virtual simulations. Critical aspects of the research were briefed to all key STO participants including the Chief of the DBBL Simulation Center, at separate STO meetings on 27 May, 29 July, and 3 November 1999.



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ANALYSIS OF MISSION-BASED SCENARIOS FOR TRAINING SOLDIERS AND SMALL UNIT LEADERS IN VIRTUAL ENVIRONMENTS

EXECUTIVE SUMMARY

Research Requirements:

Soldiers must be able to train effectively even when they do not have the opportunity to participate in realistic field training exercises. Cost-effective methods for developing soldier decision-making and leadership skills are especially needed in urban operations. One solution is to conduct a portion of this training, such as mission rehearsals, in virtual environments through the use of individual combatant simulators. There is an immediate need to generate a set of high payoff tasks that can be cost effectively represented in virtual environments. These tasks will provide the foundation for the development of soldier and small unit leader training scenarios. Once developed, the training value of these scenarios must be established.

Procedure:

A methodology for selecting high payoff tasks was developed. Twenty-three potentially suitable tasks were identified. Five tasks and five subtasks were retained to form the basis of the training scenarios. The tasks were *Assault, Move Tactically, Enter Building and Clear a Room, Reconnoiter Area, and React to Contact*. The subtasks were *Engage Targets with an M16A1 or M16A2 Rifle, Move as a Member of a Fire Team, Control Movement of a Fire Team, Perform Movement Techniques During MOUT [Military Operations on Urban Terrain], and Report Information of Potential Intelligence Value*. Scenarios were developed based on the five major tasks. Soldiers, working as teams or part of a squad, executed all task-based scenarios through the use of individual combatant simulators. Soldier performance was assessed by observers. In addition, soldier responses to the scenarios and the simulation systems were obtained from paper-and-pencil instruments and interviews.

Findings:

Soldiers were able to perform all task-based scenarios, although aspects of clearing a building were difficult to perform. While the evidence was indirect, soldiers felt that simulations improved their real-world performance on similar tasks. Overall, the simulators were seen as effective for small unit training, e.g., team coordination, communication, decision-making skills. The scenarios which provided the most training value integrated soldiers with computer generated forces to provide live force-on-force capability.

Utilization of Findings:

This research showed the potential training value of dismounted Infantry simulation technologies for soldier and small unit training, particularly, cognitive-based activities. Subsequent research will focus on the use of this technology to enhance the decision-making skills of soldiers and small unit leaders.

ANALYSIS OF MISSION-BASED SCENARIOS FOR TRAINING SOLDIERS AND SMALL UNIT LEADERS IN VIRTUAL ENVIRONMENTS

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ANALYSIS OF MISSION-BASED SCENARIOS FOR TRAINING SOLDIERS AND SMALL UNIT LEADERS IN VIRTUAL ENVIRONMENTS

Introduction

Preparing soldiers and small unit leaders (platoon, squad, and team) for the diversity of operations facing the Army now and in the future will provide many challenges to military trainers. Units no longer have the resources (time and money) needed to prepare for and conduct large-scale field training events and exercises to adequately address the variety of missions envisioned. Time, cost, and safety considerations associated with these training events and exercises will force trainers to rely more on alternative methods of training these soldiers.

Cost-effective methods for developing decision-making and leadership skills of these leaders are especially needed in urban operations. Conducting such training at existing real-world urban training sites, however, is very costly. One solution is to conduct a portion of this training, such as mission rehearsals, in virtual environments (VE) through the use of individual combatant simulators.

At the Land Warrior Test Bed at Fort Benning, Georgia, for example, the individual soldier or small unit can explore innovative approaches for conducting urban operations and mission rehearsal activities in virtual settings. Through the use of individual combatant simulators, soldiers can immerse themselves in virtual representations (data bases) of urban training sites such as the McKenna site at Fort Benning, and conduct limited missions, e.g., clear a building, conduct area reconnaissance. Virtual environments, in theory, offer soldiers the opportunity to thoroughly rehearse missions to familiarize themselves with the procedural aspects of specific tasks as well as offering a chance to examine new tactics and techniques. These simulators allow the soldiers to play out scenarios and determine the impact of various courses of action on the likely success of a mission.

While promising, opportunities for individual dismounted soldiers to train in these immersive (virtual) environments are severely limited. The Army's current simulation systems, SIMNET (Simulation Networking) and its successor, the Close Combat Tactical Trainer, provide effective training for soldiers fighting from vehicles, but not for individual dismounted soldiers (Pleban, Dyer, Salter, & Brown, 1998). Despite an organizational structure that includes light forces, few attempts have been made by the Army to model component behaviors of individual soldiers. Individual combatant simulations are needed to portray the roles and vulnerabilities of dismounted personnel in the virtual battle. Without some sort of individual combatant simulation, it is difficult to estimate the impact of the individual soldier or soldiers in squad or team size elements in conjunction with their mounted counterparts (Jacobs et al., 1994).

Dismounted Warrior Network User Exercises

A number of candidate individual combatant simulator systems were examined over the past few years under the cognizance of the U.S Army Infantry Center's Dismounted Battlespace Battle Lab (DBBL). Pleban, Dyer, Salter, and Brown (1998) conducted an exhaustive functional analysis of four prototype virtual individual combatant simulator technologies as part of the

Dismounted Warrior Network (DWN) User Exercises. The DWN work effort was a collaborative venture between the Infantry Forces and Simulation Systems Research Units of the U. S. Army Research Institute (ARI), the U. S. Army Simulation, Training, and Instrumentation Command (STRICOM) and its contractor Lockheed Martin Information Systems (LMIS) under the Advanced Distributed Simulation Technology II program. One objective of the research was to identify requirements for simulator systems to support the integration of individual soldiers into the virtual battlefield. This was accomplished through a series of engineering experiments and partially structured free play user exercises conducted at the LMIS facility in Orlando (engineering) and in the DBBL Land Warrior Test Bed (LWTB) at Fort Benning. Exercises involved both urban and desert scenarios. Pleban et al. (1998) detailed the strengths and weaknesses of each prototype system as well as needed modifications.

Dismounted Warrior Network Enhancements for Restricted Terrain Exercises

A follow-on to the DWN User Exercises was the DWN Enhancements for Restricted Terrain (DWN ERT) exercises (Salter, Eakin, & Knerr, 1999). The DWN ERT effort built upon the lessons learned from the DWN User Exercises and focused exclusively on urban operations. The virtual urban operations data base (environment) was modeled after the Fort Benning-McKenna urban operations training site.

The objective of the DWN ERT exercises was similar to the DWN User Exercises, to compare and contrast the characteristics and capabilities of four simulation technologies. The systems were based, in part on the earlier technologies used previously and described by Pleban et al. (1998). Salter et al. (1999) identified key technological issues related to weapon aiming, position tracking, and locomotion that must be addressed for the system to have any value for conducting mission training or rehearsal activities. The candidate systems were also evaluated for strengths and weaknesses.

Individual Combatant Simulation: System Characteristics, Technology, and Training Issues

Until recently, individual virtual environments have been unable to provide the richness of environmental cues and/or adequate response sensing mechanisms to be considered useful substitutes for natural world alternatives (Jacobs et al., 1994). Emerging VE technologies such as low cost computer image generators, immersive helmet mounted displays, locomotion platforms, and intelligent computer-controlled forces have attempted to address some of these deficiencies, with varying degrees of success. However, hardware and software limitations must still be addressed, as well as the lack of documented effective methods, strategies, and training support packages for simulator use.

The best performing of the currently existing individual combatant simulation systems is a prototype version of the Soldier Visualization Station (SVS) described in Salter et al. (1999) and developed by Reality by Design (RBD). This system represents the currently most viable overall technical approach for enabling soldiers to shoot, move, and communicate in virtual environments. The SVS is a PC (Pentium) based system with an inertial/acoustic tracker for body position and weapon pointing. It includes an integrated head assembly subsystem that can be used for aiming and looking around the corners of buildings. The SVS has one flat screen on

which images are presented by a rear projection device. Movement is accomplished by applying pressure to a weapon-mounted thumbstick. This allows the individual to move rather effortlessly throughout the virtual battlefield to include open terrain and urban environments.

Science and Technology Objective (STO) Work Program for Virtual Environment Research

ARI recently established a four year Science and Technology Objective (STO) entitled Virtual Environments for Dismounted Soldier Simulation Training and Mission Rehearsal (1998). The purpose of the STO is to examine selected technological and training issues that currently limit high fidelity dismounted simulation. Technological topics include limited field of view and resolution of visual display systems, simulating locomotion, tracking weapons and body positions, creating realistic performance of computer-controlled dismounted friendly and enemy soldiers, simulation of night equipment and sensor images, and making terrain and structures dynamic. Training issues addressed include the development of effective and appropriate training strategies and methods, assessing individual and unit performance, developing training materials, and determining transfer of training from virtual to live environments.

A collaborative STO effort was established between the Infantry Forces and Simulation Systems Research Units of ARI, the U.S. Army Simulation, Training, and Instrumentation Command, and the Human Research and Engineering and Information Sciences and Technology Directorates of the U.S. Army Research Laboratory to address these issues. The first year STO program was divided into five phases:

- Phase IA - First Pilot Test (Initial Evaluation of Soldier and Small Unit Leader Training Scenarios)
- Phase IB - Second Pilot Test (Evaluation of Revised Soldier and Small Unit Leader Training Scenarios)
- Phase II - ACRT Look (SVS system check)
- Phase III - Voice Instructor/Operator Evaluation
- Phase IV - DI SAF (Dismounted Infantry Semi-Automated Forces) Face Validation and Review of New DI SAF Behaviors
- Phase V - STO Training and SAF Evaluation

Only issues relevant to Phase I will be addressed in this report.

Identification of High Payoff Tasks for Virtual Environments

Fundamental to the STO Phase I work effort was the identification of high payoff tasks for training small unit dismounted Infantry soldiers and leaders in simulated urban operations. As noted earlier, budget, environment, safety, and operational pressures severely limit the frequency and quality of unit field training. A major concern for trainers is how to adequately prepare soldiers and small unit leaders for urban operations. Of particular interest was the use of innovative technologies (e.g., individual combatant simulation) to enhance the decision-making skills training of these soldiers in urban settings.

Earlier reports detailing task requirements for training dismounted soldiers in virtual environments (Jacobs et al., 1994; Lockheed Martin Information Systems, 1997) were extremely useful in shaping task selection criteria for identifying tasks which could be used for honing the decision-making skills of these soldiers in urban settings. However, the task lists generated from these efforts required additional refinements since the specific criteria used by Jacobs et al. and Lockheed Martin did not address the specific simulator characteristics of the system (SVS) to be used during the Phase I evaluation (See Pleban, 1999).

The first part of this report will describe the process used by Pleban (1999) to generate a high payoff task list for near-term use in the LWTB employing currently available individual combatant simulation technologies (SVS). The second part of the report will describe the development of the small unit (soldier and leader) training scenarios, summarize soldier and observer reactions to the scenarios, and discuss the implications of the findings for Phase V of the STO year one work effort.

PART 1

THE HIGH PAYOFF TASK SELECTION PROCESS

The selection of high payoff tasks (i.e., key Infantry tasks which can be cost-effectively represented in virtual environments for training small unit dismounted Infantry (DI) soldiers in simulated urban operations) was a four-phase process. The phases involved: a) establishing an appropriate initial list of dismounted soldier tasks; b) selecting a smaller pool of tasks that are executable in existing virtual environments; c) identifying an initial set of high payoff tasks and; d) specifying a final set of high payoff tasks.

Establishing an Appropriate Initial List of Dismounted Soldier Tasks

An initial search was conducted by Pleban (1999) to identify existing task lists that had been created recently. The search revealed two potentially relevant task lists that were mentioned earlier. The final set of high payoff tasks was based on refinements of the lists found in the Jacobs et al. (1994) report: *Training Dismounted Soldiers in Virtual Environments: Task and Research Requirements*; and Lockheed Martin Information Systems' (1997) *Training Exercises and Military Operations Functional Definition Report for Individual-to-Squad, Platoon, and Company Organization Levels*.

The two task lists did not use the same sources. Jacobs et al. (1994) relied primarily on the following documents:

- ARTEP 7-8-MTP (1988) *Mission Training Plan for the Infantry Rifle Platoon and Squad*;
- ARTEP 7-8-DRILL (1990) *Battle Drills for the Infantry Rifle Platoon and Squad*;
- ARTEP 31-807-31-MTP (1989) *Mission Training Plan for the Special Forces Company: Special Reconnaissance*;
- ARTEP 31-807-32-MTP (1989) *Mission Training Plan for the Special Forces Company: Direct Action.*

Sixty-seven tasks and drills were identified by Jacobs et al. (1994) for further analysis to determine their suitability for representation in virtual environments. Tasks identified by Jacobs were accompanied by multiple ratings from subject matter experts (SMEs) and frequency scores reflecting their standings on three key criteria: a) occurrences of task component activities; b) transfer effectiveness; and c) availability of technology to support task-related activities.

Lockheed Martin (1997) borrowed from many sources to include ARTEPs 7-8-MTP and DRILL, in addition to a number of other ARTEPs, Soldier Manuals, Special Texts, and Tables of Organization and Equipment for different Infantry units, e.g., Light, Mechanized, and for United States Marine Corps Infantry units. (See Lockheed Martin Information Systems, 1997, p. 10, for a complete list of sources used.) Pleban (1999) focused primarily on tasks found in ARTEPs 7-8-MTP and DRILL.

Lockheed Martin (1997) identified 167 tasks and drills for possible representation in virtual environments. These tasks were also rated by SMEs for suitability for virtual environments. Suitability ratings were based on a functional performance code assigned to each task. The code reflected the degree to which existing simulation systems support the training of the task. This code was then converted to a single numerical rating by following a predetermined set of decision rules. (See Lockheed Martin Information Systems, 1997, pp. 18-23.) Ratings did not reflect the transfer potential, cost-effectiveness or importance of the task to be simulated.

Tasks were considered for potential inclusion (by Jacobs et al., 1994, and Pleban, 1999) if they: a) applied to an Infantry platoon, squad, or individual within the squad; b) involved dismounted operations; c) were generally applicable to virtual environments; and d) were available in an unclassified mode (See Jacobs et al., 1994, p. 13.)

Tasks not considered (by Lockheed Martin, 1997) for selection for the final high payoff task list included, for example, a) tasks involving passive activities such as selecting temporary fighting positions, practicing noise and light discipline; b) maintenance of weapons and equipment; c) those that deal strictly with zeroing weapons and the aligning and calibrating of equipment; or d) tasks dealing with operational and safety checks of weapons and equipment; and e) tasks in which the users are mounted in any kind of vehicles (ground, aircraft, boats) with the possible exception of selected Bradley Fighting Vehicle tasks to accommodate the mounting and dismounting of the vehicle. (See Lockheed Martin Information Systems, 1997, pp. 14-17.) (Tasks involving the zeroing or alignment of items of equipment, e.g., night vision, thermal, and acquisition and aiming devices, with their associated weapons were retained for later selection.) In addition, Pleban (1999) eliminated thirty-five of the lowest rated tasks from Lockheed Martin's initial list of 165 tasks as unsuitable for inclusion in the virtual training scenarios, e.g., *Cross Water Obstacles, Establish a Roadblock, Occupy Observation Post.*

Selecting a Smaller Pool of Tasks that are Executable in Existing Virtual Environments

From this initial combined set of 199 tasks and drills (see Appendixes A and B) Pleban (1999) examined candidate tasks and drills by applying the criteria described in the following sections. These criteria were essentially the same or slightly modified versions of those Jacobs used in rating each task:

a) occurrences of task component activities; b) transfer effectiveness; c) availability of technology to support task-related activities. In addition, another criterion was applied to the tasks - the cost-effectiveness/feasibility of performing behaviors in virtual environments

Behaviors Supported by Current and Near-Term Simulation Technology

Tasks were evaluated, in part, based on the current and near term capabilities of available individual combatant simulation systems to support the behaviors or activities associated with the task. Task assessments were based on features characteristic of the Soldier Visualization Station (SVS), which will be used during the preliminary evaluation of small unit soldier and leader tasks/scenarios. Results from this pilot investigation will feed into a more comprehensive follow-on evaluation involving nine SVS immersive simulators and one desktop system, collectively termed the Squad Synthetic Environment (SSE). Salter, et al. (1999) provides a full description of the original SVS system and its variant.

If the SVS system could not support the critical behaviors that compose the major aspects of the task, then the task was not selected for the final task list. Using this criterion, examples of tasks not selected included those involving the operation and use of such weapons as the M60 machine gun, M249 machine gun, M203 grenade launcher, M9 pistol, M47 antitank weapon, M18A1 claymore mine, and various pieces of night vision equipment (e.g., night vision sight, thermal viewers, night vision goggles-NVG). The SVS does not yet support these other weapons. But it does support limited night operations (dark and low fidelity NVG simulation).

It is important to note that while Lockheed Martin (1997) acknowledged the importance of individual combatant simulation systems to be able to support specific human behaviors and activities, their task selections were based on more general considerations (see p. 3 and Lockheed Martin Information Systems, 1997, p. 18). Jacobs et al. (1994) broke their tasks down into behaviors or activities that could be supported by current, mid- or far- term technology. This categorization was used to help identify promising tasks for final selection for use on the SVS.

Analysis of Jacobs' et al. (1994) projections on the availability of technologies to support key task behaviors shows that progress has been slower than anticipated in certain areas. Some technologies identified by Jacobs et al. in 1994 as being available in the next 30-42 months to support various behaviors are still not completely developed in 1999. The most problematical area involves instances where the soldier must actively manipulate the virtual terrain in some way. This dynamic interplay between soldier and terrain includes such activities as construction of field fortifications (e.g., digging foxholes, hasty firing positions, or fighting positions with overhead cover); removing signs of presence, camouflaging fighting position, activating demolitions; camouflaging trails after passing, and crossing water obstacles. Since the current SVS system is not capable of supporting these activities, tasks involving these or similar activities were not considered for selection.

Transfer Value

Tasks were selected, in part, based on Jacobs' et al. (1994) ratings estimating the transfer effectiveness of practicing component activities individually in a virtual environment. Jacobs et

al. based their assessment on the following criteria: a) the primary sensory and effector modalities used to perform the task; b) the projected performance of the virtual simulation subsystems to realistically simulate the task using primary and secondary modalities; and c) the likelihood that virtual simulation artifacts may affect a negative transfer of training (e.g., simulator response latencies, visual resolution). Tasks regarded as having potentially high transfer value were, in general, composed of highly generalizable activities. Tasks involving the types of activities shown in Table 1 were rated by Jacobs et al. as potentially high in transfer effectiveness.

Table 1

Representative Behaviors Rated High in Transfer Effectiveness and Frequency of Occurrence in the Performance of Infantry Tasks

Activity	High Transfer	Occur Frequently
Communication		
▪ Give verbal orders	X	X
▪ Hear orders		X
▪ Give hand and arm signals	X	X
Weapon Engagement		
▪ Aim and fire individual weapon	X	X
Visual Identification-People		
▪ Perceive relative position of other units	X	X
▪ Visually search for enemy	X	X
▪ Identify actual squad members		X
▪ Identify activity of personnel	X	X
▪ Identify enemy soldiers	X	X
▪ Identify civilians	X	
Visual Identification-Location		
▪ Identify safe and danger area	X	X
▪ Identify support position	X	X
▪ Perceive relative position of weapon fire	X	X
▪ Identify areas that mask supporting element fires	X	X
▪ Identify overwatch position	X	X
▪ Identify covered and concealed route	X	X
▪ Identify assigned sectors	X	X
▪ Estimate distance from self to distant point	X	X
▪ Discern location within area	X	
▪ Identify firing positions in a building	X	
Movement		
▪ Move in accordance with directions	X	X
▪ Maintain position relative to other personnel	X	X
▪ Move upright tactically		X
▪ Move upright, reconnoiter		X

Note: This table summarizes Jacobs' et al. (1994) ratings for these two criteria.

Frequency of Occurrence

Another consideration in determining whether or not a task was selected as a potentially high payoff task was the frequency with which underlying component activities occur in performing the tasks. (See Table 1.) Jacobs et al. (1994) analyzed each ARTEP task to identify the fundamental behaviors. Frequency counts were made of the total number of times a behavior occurred across all 67 tasks and for each individual task. Based on the Jacobs et al. analysis, activities occurring 25 or more times across all tasks were retained for further analysis. While there were a few exceptions, activities meeting this criterion were examined separately for selected tasks (generally, tasks supported by current and near-term simulation technology and rated high in transfer value by Jacobs et al.). Task selections were based, in part, on the frequency with which the actions occurred in performing the task, typically, three or more times, and on subjective judgments of the criticality of the action to the performance of the task, i.e., is the action a core component of the task?

This selection process was performed only on the tasks identified by Jacobs et al. (1994) and, by extrapolation, to matching tasks found in Lockheed Martin's (1997) list. Tasks identified for potential inclusion on the final list generally included such activities as shown in Table 1 based on Jacobs' et al. frequency counts.

Cost-effectiveness/Feasibility of Performing Activities in Virtual Environments

The final criterion for task selection was the cost-effectiveness/feasibility of performing the task (and its component activities) in the virtual environment in the near-term. Tasks from Jacobs et al. (1994) which had been rated (by Jacobs et al.) across the three previous criteria (behaviors supported by current simulation technology, transfer value, frequency of activity) and matching tasks from Lockheed Martin (1997) were individually analyzed by Pleban (1999). Tasks and their component activities that could not be supported by current simulation technology were classified as non-feasible and eliminated from further consideration. Those tasks and component activities that received low ratings for transfer effectiveness or whose component activities did not meet the frequency criterion described earlier were deemed non-cost-effective and thus, unsuitable for the current SVS system.

Tasks from both Jacobs et al. (1994) and Lockheed Martin's (1997) lists that were judged to be non-cost-effective and/or feasible for performance in virtual environments tended, for the most part to involve exfiltration/infiltration tasks (e.g., *Infiltrate/Exfiltrate by Air, Infiltrate/ Exfiltrate by Water*), *Helicopter and Boat Movement*, and NBC operations, e.g., *Prepare for Chemical/Nuclear Attack, React to Chemical/Biological/Nuclear Attack, Operate in a Nuclear Environment*. Simulation of NBC tasks, for example, was not considered practical for the current SVS. Similarly, tasks involving soldiers in aircraft or boats, and to a lesser extent in ground vehicles, are not cost-effective to simulate from a training standpoint. For the small unit leader (or soldier), little, if any training value is provided by having soldiers simply entering and exiting air and boat craft or land vehicles.

Identifying an Initial Set of High Payoff Tasks

Based on the considerations discussed above, an initial list of potentially suitable tasks was identified. Again, there was a clear subjective component involved in trying to juggle the task (and its component behaviors) among the four major criteria. Different objectives and simulation systems with improved capabilities might have led to a different and/or an expanded set of tasks. It is important to note that the final list represents a snapshot in time based on current and short-term future capabilities of existing prototype simulation systems (i.e., the SVS). Table 2 combines the tasks/drills from both Jacobs et al. (1994) and Lockheed Martin's (1997) original task lists that were identified as potentially suitable for dismounted Infantry (DI) small unit training in virtual environments, with a particular emphasis on urban operations.

Table 2

Potential High Payoff Tasks for DI Small Unit Training in Virtual Environments

Tasks	Jacobs et al. (1994)	Lockheed Martin (1997)
Movement		
▪ Move as a Member of Fire Team		X
▪ Move Dismounted	X	X
▪ Move Tactically	X	X
▪ Perform Movement Techniques During MOUT		X
▪ Control Movement of a Fire Team		X
MOUT		
▪ Enter a Building and Clear a Room-Squad (Drill)	X	X
▪ Defend MOUT/Building	X	X
Reconnaissance		
▪ Recon Objective	X	X
▪ Report Information of Potential Intelligence Value		X
▪ Reconnoiter Area	X	X
▪ Engage Targets with an M16A1/A2 Rifle		X
▪ Execute Assault	X	X
▪ Perform Overwatch/Support by Fire	X	X
▪ Perform Hasty Ambush	X	X
▪ React to Contact (Battle Drill)	X	X

Note: Move Dismounted and Recon Objective were not specifically listed by Jacobs et al. (1994) but were judged as integral aspects of the respective tasks Move Tactically and Reconnoiter Area.

The combination of task lists yielded some redundancy, e.g., *Assault, Overwatch, Hasty Ambush, Defend Built-Up Area/MOUT-Building*. After further analysis of the tasks shown in Table 2, it was apparent that Lockheed Martin's (1997) task list represented a combination of tasks from FM 7-8 and component task activities similar to those identified by Jacobs et al. (1994). Indeed, these behaviors appeared more like subtasks which could be subsumed under the

larger tasks from FM 7-8 and identified by both sets of authors. For example, the task *Move Tactically* would include, to varying degrees, the activities (subtasks) *Moving as a Member of a Fire Team*, and *Performing Movement Techniques During MOUT*. Soldiers role playing the squad-fire team leader positions would also be responsible for *Controlling the Movement of a Fire Team*.

Engaging Targets with an M16A1 or M16A2 Rifle is a key behavioral component or subtask which underlies the tasks *Assault*, *Enter a Building and Clear a Room,* and *React to Contact*. Similarly, *Report Information of Potential Intelligence Value* was viewed as a critical subtask falling under the task *Reconnoiter Area* as well as for *Move Tactically*, *React to Contact*, *Assault*, and *Enter a Building and Clear a Room*.

Specifying a Final Set of High Payoff Tasks

Further analysis of Table 2 resulted in the elimination of some additional tasks. For example, *Overwatch* and *Defend Built-Up Area* were removed from consideration because they were judged as too passive (too little movement for individual combatants) to be effectively crafted into small unit leader training vignettes. *Hasty Ambush* was also eliminated from consideration because of the difficulty in executing the task using the prototype SVS systems in conjunction with the urban-based context of the scenarios. The final task list determined to be appropriate for virtual environments is shown in Table 3 with redundant/inappropriate tasks removed and the remaining ones reorganized into tasks and supporting subtasks.

Table 3

High Payoff Tasks for DI Small Unit Training in Virtual Environments

Tasks
▪ Assault ▪ Move Tactically ▪ Enter Building and Clear a Room ▪ Reconnoiter Area ▪ React to Contact
Subtasks
▪ Engage Targets with an M16A1 or M16A2 Rifle ▪ Move as Member of a Fire Team ▪ Perform Movement Techniques During MOUT ▪ Report Information of Potential Intelligence Value ▪ Control Movement of a Fire Team

Conclusion

The development of DI small unit leader training scenarios for execution in the simulation environment is described in Part 2 (Phase I) of this report and is based on the tasks and subtasks shown in Table 3. As previously noted, the selection of these tasks was based on the systematic reduction of a great number of tasks down into a manageable, useful task list which may provide researchers and trainers the material necessary to maximize the effectiveness of individual combatant simulation for training and mission rehearsal activities. In terms of training value, these tasks should offer the highest payoff potential for soldiers and small unit leaders.

The results from a preliminary evaluation of the training scenarios is described in Part 2. The major objectives of the evaluation were to identify vignettes (and their associated tasks) which may be performed in the simulation environment and which appear to have training value for Infantry soldiers. The training scenarios served as the primary instructional vehicles for the Phase V follow-on evaluation involving the Squad Synthetic Environment and is described in a separate report.

PART 2

PHASE I OVERVIEW

The second part of this report describes the Phase I scenario development process, the major findings from the evaluation, and research and design implications for the final phase (Phase V) of the year one STO work program. Phase IA involved the initial development and evaluation of five sets of task-based scenarios. Phase IB focused on the potential training value of modifications made to selected sets of scenarios from Phase IA.

The scenarios were evaluated across a number of training issues. Key research issues are listed below.

- Could the tasks and their component behaviors be performed adequately in the virtual environment?
- What tasks were the most difficult to perform in the virtual environment?
- Could practice in simulations lead to improved performance in the real world?
- How could simulators be used most effectively for small unit training?
- Were the scenarios appropriate for small unit leader training?
- What types of scenarios provide the most training value?
- What enhancements or modifications are needed to improve the training value of the scenarios?

- What do scenarios need to emphasize from the perspective of small unit training?
- What were the strengths and weaknesses of the scenarios?
- How do dismounted Infantry semi-automated forces (DI-SAF) impact the training value of the scenarios?

PHASE 1A
INITIAL EVALUATION OF SMALL UNIT LEADER TRAINING SCENARIOS

Method

Participants

Participants were six male soldiers from Fort Benning. All soldiers had from two-and-one-half to thirteen years in service time (mean time in service - five and one-half years) and were MOS 11M (Fighting Vehicle, Infantryman) qualified. The average age of the participants was 26.8 years (range - 23 to 34 years). The sample contained all E-5s (one squad leader, four team leaders, and one Bradley Fighting Vehicle gunner). All soldiers had completed the Primary Leader Development Course. Two soldiers had received some training in urban operations and three soldiers had some prior simulation experience (Conduct of Fire Trainer/SIMNET).

Materials

Biographical Information Questionnaire. The Biographical Information Questionnaire (Appendix C) was a multiple choice/short answer paper-and-pencil instrument designed to assess the soldiers' prior military training and experience, as well as experience with computers and military simulations.

Simulator Capability Questionnaire (part 1). The Simulator Capability Questionnaire (Appendix D) was a four-point multiple choice rating form that soldiers completed following the completion of each cluster of task-based scenarios. The forms consisted of specific behaviors which were judged critical for the performance of the task. For example, critical behaviors for the task Move Through a Built-Up Area included: "Maneuver around obstacles"; "Maneuver close to others"; and "Determine other team members' positions." Soldiers rated their ability to perform each behavior in the simulator from Very Good to Very Poor.

Simulator Capability Questionnaire (part 2). The second part of the Simulator Capability Questionnaire (Appendix E) was filled out by the soldiers after they had completed all the scenarios. The questionnaire was primarily short answer and tapped the soldiers' opinions on the training value/utility of the simulators, realistic and unrealistic aspects of the simulations, and training distracters.

Behavioral Observation Checklist. The Behavioral Observation Checklist (Appendix F) was completed by ARI researchers each time they observed a soldier's performance during a particular scenario. The checklists were similar to the Simulator Capability Questionnaire which

the soldiers completed, but were more detailed. Observers checked whether the soldier performed a specific behavior. Space was allocated for comments where appropriate.

Structured Interview. After completion of all scenarios for Phase IA, the soldiers were also interviewed (Appendix G) by the researchers to clarify issues noted in the observations and to obtain specific information related to:

- The best use of simulator technology
- The training value provided by specific tasks
- Which tasks were the most difficult to perform in the simulator
- Simulator improvements needed
- Factors limiting simulator effectiveness
- Training transfer
- Features needed for improving simulator capabilities

Development of Small Unit Leader Training Scenarios

The majority of scenarios involved some degree of interaction between soldiers (in their individual combatant simulators) and computer-generated DI-SAF (Dismounted Infantry Semi-Automated Forces). The DI-SAF provided either an Opposing Force (OPFOR) or a BLUFOR (Blue Forces) element in support of the soldiers. Some scenarios involved both DI-SAF OPFOR and BLUFOR elements.

Scenarios were based on the five tasks *(Move Through Built-Up Area, Reconnoiter Area, React to Contact, Assault, and Clear Building)* and subtasks shown in Table 3. Three scenarios were developed for each task. Scripts were drafted for each scenario detailing the assembly area, objective, positioning of enemy, civilians, and vehicles (Appendix H). Draft scenarios were reviewed and modified, where appropriate, by military SMEs. ARI and military SMEs pilot-tested each scenario and made additional refinements. Maps were made of the McKenna urban operations training site which served as the virtual setting for the scenarios. The maps were issued to soldiers prior to each scenario and showed the direction their team would take through the McKenna data base. As an aid to the soldiers, key procedures and behaviors which were critical to the successful performance of the scenario were summarized and placed at the corner of the map.

Apparatus

Two full-immersion SVS systems were employed along with a desktop version. The desktop system was joystick controlled. The two stand alone systems were linked to the desktop. Technical specifications of the two systems are shown in Table 4. Soldiers in each SVS could communicate with each other and their squad/team leader on the desktop. The two SVS systems were housed in their own enclosures. These enclosures were made of a thick black cloth-like material and fastened to a metal frame surrounding the SVSs. They were designed to dampen extraneous sound, reduce light, and minimize distractions from other people moving around the area.

Table 4

Technical Specifications of the SVS and SVS Desktop Simulation Systems

SVS System Specifications	
System Hardware (Stand-up and Desktop)	• Pentium III – 450 MHz microprocessor • 128 Mb RAM • Obsidian 200 – 8440 3D Graphics Card • SoundBlaster AWE 64 Gold Audio Card • Removable 4.55 GB SCSI Hard Drive
Movement Control	• Weapon-mounted thumbswitch • Desktop SVS – Microsoft joystick control
Motion Capture/ Weapon Tracking	• InterSense Mark2 X-Bar Tracking System • Weapon tracking accurate to within ½ of 1°
Visual Display	• 90° x 60° FOV at center of enclosure (varies with position change) • Rear screen projection resolution 1024 x 768 • Desktop SVS resolution 800 x 600
Enclosures	• Aluminum frame over black sound-dampening fabric. (10 x 10 x 12)
Software	• Reality By Design proprietary software

Design and Procedure

Training phase. Training took place at the DBBL's Land Warrior Testbed at Fort Benning. Prior to the start of training, soldiers were briefed on the objectives of the research and filled out the Biographical Information Questionnaire. Soldiers were then given a brief orientation on the SVS systems and shown how to operate them. Training concluded with the soldiers performing two scenarios which required them to move through urban areas, move within buildings, engage, and shoot targets. During training, ARI researchers, aided by two (active duty and retired) Army Infantry officers observed the soldiers' performance and provided immediate feedback to correct inappropriate behaviors as well as assistance to the soldiers regarding any problems they may have had with the simulators. The orientation and training phase lasted approximately one half-day.

Experimental phase. For the next two-and-one-half days soldiers worked as three-man teams: two soldiers operated the more immersive SVS and the team/squad leader operated the SVS desk top. Prior to the start of the scenarios, soldiers were reminded to operate in as tactically correct manner as possible, e.g., use appropriate movement techniques for moving around windows and near buildings, and employ correct tactics for entering and clearing buildings. Once the team was in place on the systems, they executed all three scenarios developed for a given task. When they finished their cluster of scenarios, they rotated out of the SVS systems and the next team replaced them. The team which had just finished went to the conference room and completed the appropriate Simulator Capability Questionnaire for the task-

based scenarios they had just executed. Teams completed five sets of scenarios, three scenarios for each of five tasks.

The original experimental design allocated extra time to repeat scenarios since only five soldiers were originally expected to participate in the study. The extra scenarios were added to allow the squad/team leader who was scheduled to operate the SVS desktop for all fifteen scenarios to have an opportunity to use the other (more immersive) SVS system. The extra (sixth) soldier allowed for some flexibility in the experimental design. The relative ease with which soldiers were able to perform the tasks, coupled with the fact that there was no longer a need to repeat some of the same scenarios to allow full participation, permitted the development and execution of additional challenging scenarios. To increase the complexity of the scenarios, two additional SVS systems were activated. In addition, a four-man DI-SAF team was attached as a BLUFOR fire team in support of the five SVS systems. Several squad-size scenarios involving movement to, entering and clearing a building were then executed.

McKenna phase. After all virtual environment scenarios had been completed, the soldiers were taken to the actual live McKenna training site. Soldiers conducted two basic scenarios, both of which involved clearing a building. The first scenario required them to clear a building that they had seen in the virtual world but one which they had never trained on before and they had not seen from the inside. The second building was one in which the soldiers had practiced extensively at the Land Warrior Test Bed and so they were quite familiar with the inside layout (stairs, room arrangement) of the building. Soldiers were split into two elements. A two-man team (BLUFOR) was assigned to occupy the building and defend it from the four-man team (OPFOR) which was attempting to clear it. Each scenario was run twice from each building.

On the final day of the study, the soldiers reported to the Land Warrior Test Bed where they filled out the second part of the Simulator Capability Questionnaire. In addition, small group structured interviews were conducted.

Results

Subjective Assessment of Task Performance

Soldiers' assessments of their ability to perform the five major high payoff tasks were determined by summing their individual ratings for each component behavior listed for the particular task on the Simulator Capability Questionnaire and calculating an overall mean rating. Figure 1 shows soldiers rated their overall ability to perform the five main tasks somewhere between Good and Very Good.

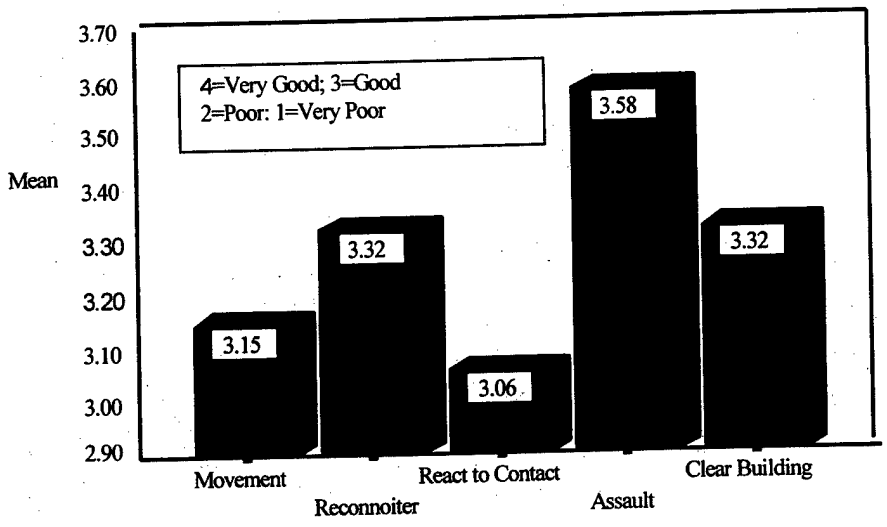

Figure 1. Soldiers' overall mean ratings of their abilities to perform five high payoff tasks in the SVS.

Mean ratings of soldiers' abilities to perform each of the component behaviors for each task are shown in Tables 5-9. Careful inspection of the tables revealed that while the large majority of mean ratings were 3.0 (good) and above, several key behaviors fell below this mark. While the disparity was minimal from an absolute standpoint, observations (and subsequent reports) from the soldiers suggested that these were areas that need to be addressed by the next generation SVS . For the task "Move through Built-Up Area" the three lowest rated behaviors were *Move around obstacles*, *Maneuver around corners,* and *Look around corners*. The task "React to Contact," had two behaviors rated as poor, *Visually locate the source of enemy fire* and *Determine the source of enemy fire by sound*, and one task was borderline (2.7 - 2.9), *Communicate enemy location to team member*. "Clear a building" had two behaviors which from the soldiers' ratings and subsequent feedback, were viewed as problematical, *Move quickly through doorways*, and *Take a tactical position within a room.*

Table 5

Soldiers' Ratings of their Abilities to Perform Component Behaviors for the Task "Move Through Built-Up Area"

Behaviors	N	Min.	Max.	Mean	SD
1) Move through open areas as a widely separated group	5	2.0	4.0	3.2	.84
2) Move according to directions	5	3.0	4.0	3.2	.45
3) Move around obstacles	5	2.0	3.0	2.8	.45
4) Move single file	5	3.0	3.0	3.0	.00
5) Maneuver below windows	5	3.0	4.0	3.8	.45
6) Maneuver close to others	5	2.0	4.0	3.2	.84
7) Determine other team member's position	5	2.0	4.0	3.4	.89
8) Maintain position relative to other team members	5	2.0	4.0	3.0	1.0
9) Maneuver around corners	5	2.0	4.0	2.8	.84
10) Locate assigned areas of observation	5	3.0	4.0	3.4	.55
11) Look around corners	5	2.0	4.0	2.8	.84

Note: 4=Very Good; 3=Good; 2=Poor; 1=Very Poor

Table 6

Soldiers' Ratings of their Abilities to Perform Component Behaviors for the Task "Reconnoiter Area"

Behavior	N	Min.	Max.	Mean	SD
1) Execute planned route	6	4.0	4.0	4.0	.00
2) Identify assigned sectors of observation	6	3.0	4.0	3.5	.55
3) Maintain position relative to other team members	6	3.0	4.0	3.3	.52
4) Look around corners	6	2.0	4.0	3.2	.75
5) Move close to walls	6	2.0	4.0	3.0	.63
6) Scan from side to side	6	3.0	4.0	3.3	.52
7) Scan vertically	6	2.0	4.0	3.2	.75
8) Identify civilians	6	2.0	4.0	3.3	.82
9) Identify enemy soldiers	6	3.0	4.0	3.3	.52
10) Identify potential danger points	6	3.0	4.0	3.4	.52
11) Estimate distances from self to a distant point	6	2.0	4.0	3.0	.63
12) Communicate spot reports to squad leader	6	3.0	4.0	3.7	.52

Note: 4=Very Good; 3=Good; 2=Poor; 1=Very Poor

Table 7

Soldiers' Ratings of their Abilities to Perform Component Behaviors for the Task "React to Contact"

Behavior	N	Min.	Max.	Mean	SD
1) Visually locate the source of enemy fire	6	2.0	3.0	2.3	.52
2) Determine the source of enemy fire by sound	6	1.0	3.0	2.0	.63
3) Distinguish between friendly and enemy fire	6	2.0	4.0	3.0	.89
4) Identify civilians	6	4.0	4.0	4.0	.00
5) Communicate enemy location to team member	6	1.0	3.0	2.7	.81
6) Take hasty defensive positions	6	3.0	4.0	3.3	.52
7) Aim weapon	6	3.0	4.0	3.5	.55
8) Fire weapon in short bursts	6	3.0	4.0	3.2	.55
9) Fire weapon accurately	6	3.0	4.0	3.5	.55

Note: 4=Very Good; 3=Good; 2=Poor; 1=Very Poor

Table 8

Soldiers' Ratings of their Abilities to Perform Component Behaviors for the Task "Assault"

Behavior	N	Min.	Max.	Mean	SD
1) Identify covered and concealed routes	5	3.0	4.0	3.6	.55
2) Identify areas that mask supporting fires	5	3.0	4.0	3.6	.55
3) Coordinate with other squad members	5	3.0	4.0	3.8	.45
4) Execute the assault as planned	5	3.0	4.0	3.6	.55
5) Move quickly to the point of attack	5	3.0	4.0	3.6	.55
6) Assume defensive positions	5	3.0	4.0	3.4	.55
7) Identify safe and danger areas	5	3.0	4.0	3.4	.55
8) Locate support team positions	5	3.0	4.0	3.6	.55
9) Locate buddy team member firing positions	5	3.0	4.0	3.6	.55

Note: 4=Very Good; 3=Good; 2=Poor; 1=Very Poor

Table 9

Soldiers' Ratings of their Abilities to Perform Component Behaviors for the Task "Clear a Building"

Behavior	N	Min.	Max.	Mean	SD
1) Take a position to one side of a doorway	6	3.0	4.0	3.2	.41
2) Move quickly through doorways	6	2.0	4.0	2.8	.75
3) Take a tactical position within a room	6	2.0	3.0	2.8	.41
4) Scan the room quickly for hostile combatants	6	3.0	4.0	3.3	.52
5) Engage targets within a room	6	3.0	4.0	3.3	.52
6) Identify non-combatants within a room	6	3.0	4.0	3.7	.52
7) Maneuver past other personnel within a room	6	2.0	4.0	3.0	.52
8) Understand verbal commands	6	3.0	4.0	3.8	.41
9) Identify sector of responsibility	6	3.0	4.0	3.3	.52
10) Communicate spot reports to squad leader	6	3.0	4.0	3.8	.41

Note: 4=Very Good; 3=Good; 2=Poor; 1=Very Poor

Observer Assessment of Task Performance

In addition to the soldiers' assessments of their own abilities to perform specific tasks and related behaviors, ARI observers also provided an independent assessment of task performance. Using behavioral checklists developed for each of the five major tasks, observers checked whether the soldier performed the specific behavior in question. Since soldiers were run in teams (A and B), a combined frequency count was calculated for each team. Instances where the soldier had problems performing the behavior or where system malfunctions precluded its performance were noted by the observers. Tables 10-14 summarize the results from the observations. Key findings are presented by task in the following sections.

Move through built-up area. In general, the soldiers had little difficulty moving through the McKenna data base. Soldiers were able to maintain position with each other and move tactically. They were able to move below windows and they showed proper techniques in looking around the corners of buildings. Soldiers had few problems in identifying all civilians and vehicles. When civilians were not identified, it was because they were out of the soldiers' line of sight. Table 10 shows that in the majority of instances the soldiers did not move single file near buildings. This can probably be attributed to the fact that there were only two soldiers. The third soldier, the team leader, operated the desktop SVS and stayed in the rear but within sight of the other soldiers. The remaining soldiers who performed the actual movement through McKenna said they thought that it would be better, tactically, to split up, with one soldier walking on one side of the street, staying close to (hugging) the buildings, and the other doing the same on the opposite side of the street. When caught silhouetting himself in a window, one soldier indicated that he was covered by his buddy from across the street and did not feel that he was compromising the mission.

Table 10

Frequencies with which Component Behaviors were Performed (by Team) for the Task "Move Through Built-Up Area"

Behavior	Team A		Team B	
	Yes	No	Yes	No
1) Move single file? (when applicable)	1	5	0	6
2) Maintain position with one another?	6	0	5	0
3) Move tactically?	6	0	4	1
4) Move below windows?	6	0	3	3
5) Look around corners correctly?	4	1	4	1
6) All civilians and vehicles identified?	4	2	6	0
7) Cross street as dispersed group?	4	1	2	2
8) Adequate spot report made?	6	0	5	0
Total	37	9	29	13

Reconnoiter area. Typically, soldiers had little difficulty in identifying civilians or enemy soldiers. At times, they only incompletely identified vehicles or ignored them (observed once). Soldiers had difficulty in determining distances. Although prodded initially at the beginning of the scenarios to provide distance estimates in their spot reports to the squad leader, this behavior did not continue for long. Apparently, the focus of the soldiers was avoiding detection by the OPFOR and planning their next set of movements, and this seemed to overwhelm other activities. This also seemed to be the case for two other key behaviors, *Identifying areas masking supporting fires* and to a lesser degree, *Identifying supporting positions* which were infrequently, if ever performed. (See Table 11.)

Table 11

Frequencies with which Component Behaviors were Performed (by Team) for the Task "Reconnoiter Area"

Behavior	Team A		Team B	
	Yes	No	Yes	No
1) Move tactically?	6	0	6	0
2) All civilians/vehicles identified en route?	6	0	5	1
3) Safe and danger areas identified?	2	3	4	2
4) Could distances be determined?	2	2	0	6
5) All enemy/vehicles identified at objective?	2	3	3	3
6) All enemy identified at adjacent areas?	6	0	6	0
7) Supporting positions identified?	1	4	3	2
8) Areas masking supporting fires identified?	0	5	0	5
9) Adequate spot report made?	6	0	5	0
Total	31	17	32	19

React to contact. This task could more correctly be termed an assault, since the BLUFOR (SVSs) had to initiate contact with the OPFOR. Preliminary testing of these scenarios showed that once the DI-SAF OPFOR made line-of-sight contact with the BLUFOR, they would engage and kill the BLUFOR almost instantly. To salvage the scenarios, the lead DI-SAF OPFOR soldier, who would be detected first by the BLUFOR, had his weapon system placed on "hold fire." This allowed the BLUFOR time to detect the OPFOR soldier, get in position, and then initiate contact. Once contact was made, the OPFOR soldier could return fire, if not already killed by the BLUFOR. While the behaviors from the checklist were probably still valid for this task, the pattern of results shown on Table 12 does not completely reflect the soldiers' performance for the task "React to Contact." One behavior that was particularly difficult for soldiers was *Identifying enemy positions by sound.* The SVS systems used in this pilot study did not allow for clear localization of sounds.

Table 12

Frequencies with which Component Behaviors were Performed (by Team) for the Task "React to Contact"

Behavior	Team A		Team B	
	Yes	No	Yes	No
1) Move tactically?	6	0	6	0
2) Maintain position relative to each other?	6	0	6	0
*3) Take immediate cover when fired upon?	3	0	4	1
*4) Return fire immediately?	2	3	3	0
5) Appropriate fire commands by team leader?	3	1	3	0
6) Were enemy positions accurately located?	5	1	5	1
7) Enemy positions located by sound?	2	4	0	3
8) Accurate situational assessment by team leader?	2	1	3	1
9) Adequate spot reports made?	4	1	3	0
Total	33	11	33	6

*BLUFOR fired first.

Assault. System characteristics played a major role in moderating the pattern of results obtained for this task. System artifacts clearly depressed the frequency of occurrence of a number of behaviors. In these scenarios soldiers were linked with a DI-SAF BLUFOR fire team element. Typically, the squad leader would have the DI-SAF fire team move out ahead of the soldiers to locate the DI-SAF OPFOR and initiate contact. The quickness with which the DI-SAF elements move (compared to soldiers in the SVS) coupled with the marksmanship accuracy of the DI-SAF, frequently led to very short engagements fought primarily between the two SAF elements. (See Table 13.)

Table 13

Frequencies with which Component Behaviors were Performed (by Team) for the Task "Assault"

Behavior	Team A		Team B	
	Yes	No	Yes	No
1) Was a plan developed?	3	0	3	0
2) Were support positions identified?	3	0	3	0
3) Were areas masking supporting fires identified?	3	0	3	0
4) Was a spot report made prior to assault?	3	0	3	0
5) Did squad leader check position of all elements?	2	1	3	0
6) Did squad leader effectively control suppressive fires?	2	1	3	0
7) Was heavy volume of fire delivered on objective?	2	1	3	0
8) Did squad leader order movement to objective?	3	0	1	2
9) Was objective secured?	2	1	3	0
10) Adequate spot reports made?	3	0	3	0
11) Was assault executed as planned?	6	0	6	0
Total	32	4	34	2

Clear a building. Soldiers had few problems performing the majority of task related behaviors. Soldiers were able to correctly discriminate civilians from enemy, they engaged all targets with short bursts of fire and showed an awareness of their assigned sectors of fire. While the soldiers knew how to "stack" (maintain close formation) in front of a door, the system made it difficult to enter smoothly through a door as their computer images (avatars) got tangled with other avatars if they got too close to each other. Another system problem that was noted was that the avatar almost always depicted the soldier as holding his rifle and pointing it at the small of the back of the soldier in front of him, while waiting in front of a door, even if he was not actually holding his rifle in this manner. Checking for booby traps and marking the doors of cleared rooms, while critical behaviors, could not be performed using the current SVS system. (See Table 14.)

Table 14

Frequencies with which Component Behaviors were Performed (by Team) for the Task "Clear a Building"

Behavior	Team A		Team B	
	Yes	No	Yes	No
1) Appropriate positions taken outside doors?	6	0	6	0
2) Doors checked for booby traps?	0	6	0	6
3) Weapons held appropriately?	6	0	6	0
4) Rooms entered tactically?	3	2	6	0
5) Were targets engaged with short bursts?	5	0	5	0
6) Verbal commands given to direct next soldier into room?	3	2	6	0
7) Soldiers aware of assigned sectors of fire?	4	1	5	0
8) Were all targets engaged?	6	0	6	0
9) Civilians and enemy correctly discriminated?	5	0	5	1
10) Verbal indication given that room was clear?	5	1	6	0
11) Indication given that room was marked as cleared?	0	5	0	4
12) Adequate spot report given?	6	0	4	0
Total	49	17	55	11

Performance on Revised Scenarios (Clear a Building)

The revised "Clear a Building" scenarios with two additional immersive SVS systems and a four-man DI-SAF fire team attached to the BLUFOR were expected to be more challenging for the soldiers. In reality this was not the case. The squad leader tended to use the DI-SAF fire team primarily as a support element and position them in a location removed from the soldiers in the SVS systems. The mission would then be conducted by the soldiers with little interaction from the DI-SAF element. Although only two of the revised scenarios were observed, it was clear that the DI-SAF provided little training value to the small unit leader and his soldiers.

Most Difficult Tasks to Perform in the Simulator.

Clearing a building was the most difficult task for soldiers to perform in the SVS systems. Soldiers felt that the system, as currently configured, could lead to the development of bad habits in the execution of this task. For example, "stacking" in front of doors was difficult to practice correctly in the virtual environment because soldiers were unable to use appropriate muzzle discipline. Soldiers indicated that they need to feel not only the muzzle of their team member's rifle (on their shoulder) but be able to feel the soldier near them, which cues their movement. Without this sense present, soldiers adapted to the limitations of the SVS and did not perform certain behaviors as called for in similar real world situations. When they cleared buildings at the actual McKenna test site, soldiers performed as they had practiced at the LWTB. For some, this resulted in inappropriate behavior, e.g., failure to do rear security, which required moving in contact with a team member back-to-back.

Another system problem which could lead to the development of bad habits, was the soldiers' virtual representations (avatars) in the data base. The avatars most often depicted the

soldier as having his rifle pointed in the small of the back of the soldier in front of him, even if the soldier was correctly pointing his weapon. The lengthy exposure of such poor weapon handling techniques (without feedback or comment) could unwittingly lead the soldier to consider such techniques as acceptable.

Additional behaviors soldiers had difficulty performing while clearing a building were going through doors (smoothly) with others and scanning. Part of the problem, as mentioned earlier, was that the avatars became tangled up as they got close together which made it difficult to go smoothly through doors. Moving and scanning were also affected by system constraints which limited the soldiers' situational awareness. Their field of view was less than what they were used to and it was hard to look up and down easily. Once inside the building, and casualties taken, soldiers had difficulty moving around or over dead people. They appeared to get stuck as they tried to step over the bodies.

For some soldiers, the microphone was problematical. They claimed that the positioning of the microphone on the headset prevented them from holding their weapon correctly. A soldier could correctly hold his rifle close to the right side of his face. But when he shifted the rifle to the left side, the microphone, which was located on the left side of the headset, would make it difficult for the soldier to position the rifle comfortably on this side.

Learning Transfer

Soldiers were asked if participation in the simulations at the LWTB had any effect on their performance at the McKenna training site. Although poor transfer of some behaviors were observed, they felt that the simulation improved their real-world performance. Prior practice in the simulations allowed soldiers who had never worked with each other to practice as a team and develop SOPs. A key advantage to practicing in the McKenna data base prior to going to the actual site was that soldiers had the opportunity to go through one of the buildings they would be clearing ahead of time and familiarize themselves with the layout of the rooms, stairs, etc. Soldiers felt that practice at the virtual McKenna site helped minimize their planning time at the actual site since they had already rehearsed clearing one of the buildings at the LWTB and were mentally prepared for the upcoming mission.

Use of Simulators for Small Unit Training

From the soldiers' perspective, simulators can be used effectively to practice coordination between teams and develop communication skills. They also felt that they could be used for mission rehearsal. Practice in these virtual environments would allow the soldiers to develop various courses of action (COA) and to play them out against an OPFOR. The soldiers felt this would be very useful. These rehearsal exercises could also be used to sharpen small unit leader decision-making skills.

Scenario selection. To maximize the effectiveness of the simulators for soldier and small unit leader training, the appropriate scenarios must be used. Overall, soldiers had few complaints with the task-based scenarios that were developed. "React to Contact" had the most training value for soldiers. However, they would have preferred (React to Contact) scenarios

with the OPFOR initiating fire. Soldiers also indicated that they would have liked to have executed some non-MOUT scenarios as well, e.g., assault in a wooded area.

Simulator distracters. Anything which reduces the immersive quality of the simulation can lessen the training value of the scenarios by breaking the soldiers' concentration or causing them to behave differently than in the real world. Soldiers mentioned a number of distracters which must be addressed in the near future. The audio wires which were attached to the headset worn by the soldier were a major distracter. Every time the soldier tried to move from one side of his enclosure to the other, he had to step through and lift a nest of wires. This proved very annoying for the soldiers. As noted earlier, another problem with the headset was the microphone, which would get in the way as the soldier switched firing positions from his right side to his left.

The stacking problem with the avatars as the soldiers stood outside doors (mentioned earlier), disrupted soldier concentration. When the soldiers clustered together, their avatars got tied up with each other, making it difficult to enter rooms quickly and in an organized way. Both inside and outside the buildings the system gave the soldier no capability to use arm-and-hand signals. This tended to reduce the realism of the scenarios as the soldiers were forced to rely on (perfect) radio communication among themselves in which everyone was able to both hear and communicate with everyone else.

All soldiers viewed DI-SAF as too "hokey." This was particularly apparent when the "Assault" and revised "Clear a Building" scenarios were run with a DI-SAF fire team. The combination of the DI-SAF moving too fast for the soldiers, accurate marksmanship, and limited responsiveness to real time commands and contingencies, limited the training value of this feature for the soldiers. As a result, the DI-SAF element was moved to out-of-the way locations in a support role and was ignored or infrequently utilized by the team/squad leader. After their experience at the real McKenna site, soldiers indicated a strong preference to go against a live OPFOR in the LWTB as opposed to one composed entirely of DI-SAF elements.

Another distracter for soldiers was getting stuck in walls. While they had a general understanding why this occurred, it nevertheless was bothersome and may have interfered with their concentration in the scenarios.

There was some sentiment that the rifle used was not as realistic as it could be. Factors mentioned which reduced the realistic feel of the rifle included weight (too light), trigger squeeze (too smooth), front sight post (too wide), and inadequate recoil.

Finally, while soldiers indicated that the cloth enclosures did not increase feelings of immersion, they did say that the enclosures were helpful for sound dampening and reducing visual distractions, e.g., people moving around, lights.

Simulator Improvements

Soldiers provided recommendations on simulator features which need improvement or which should be added to the next SVS prototype system. Several of these features (ability to move around dead people and hand-and-arm signals) were mentioned earlier. These recommendations are listed in Table 15.

Table 15

Simulator Features which Need to be Improved or Added to the Next Generation SVS

Feature Areas
Movement ▪ Ability to move around dead soldiers ▪ Ability to run and scan at the same time ▪ Ability to go through windows and low crawl over walls
Weapon Use and Capability ▪ Ability to see muzzle flash ▪ Increase cues for when magazine runs out of rounds ▪ Restrict rounds (Limit number of times ammo clip can be reset) ▪ Improve capability to localize (weapon) sound ▪ P(Kill/Hit) should not equal 1.0 ▪ Additional weapon capability (SAW, M-60, M-240, grenades)
Communication ▪ Ability to use hand and arm signals ▪ More realistic commo: from SL to TL then TL to team
Other ▪ Add furniture/obstacles inside and outside of buildings ▪ More varied and responsive civilians, e.g., men, women, children, civilians carrying (firing) weapons ▪ Ability to determine elevation (high or low ground) ▪ Increase visual scene - vertically and horizontally ▪ More immediate performance feedback ▪ Realistic attempt to incorporate CASEVAC procedures in scenarios

Non-Simulator Related Training Enhancements

Soldiers also provided some additional comments (non-simulator based) related to enhancing the training effectiveness of the simulations. They felt that soldiers should have to wear their basic combat load, e.g., canteen, and ammo pouches. In addition they should be required to use new magazines from their ammo pouches when they run out of ammunition and keep track of (count) their rounds to replicate what they would do in the real world. Overall, the soldiers recommended the following order of events for enhancing training effectiveness of simulations: simulation (rehearsal), conduct training exercises in the field, simulation (refine, practice and rehearse from lessons learned in the field). They felt that this approach would save

bullets, reduce OPTEMPO, fuel costs, and range use. The key is to use simulation to fix mistakes, so the unit will be more efficient in their training when they are in the field.

Discussion

Soldier Performance on Task-Based Scenarios

The significant improvements in shooting accuracy and the relative ease of moving using the weapon mounted thumbstick compared to earlier ICS prototypes (Pleban et al. 1998; Salter et al., 1999) enabled soldiers to perform most task component behaviors relatively easily. Overall, soldiers had few problems performing the task-based scenarios. From the soldiers' perspective, however, several behaviors remained problematical. The behaviors which they found most difficult to perform were *Move around obstacles*, *Maneuver around corners*, *Look around corners*, *Move quickly through doorways* and *Take a tactical position within a room.* The core problem behind all these behaviors is a lack of computer power which limits the extent to which these tasks can be simulated with complete fidelity in the current SVS prototype (used in Phase IA). The inability to smoothly perform these behaviors made the "Clear a Building" scenarios, in particular, difficult to execute and limits the utility of these scenarios for the accurate rehearsal of specific techniques, e.g. stacking and entering buildings, movement inside buildings. While these behaviors were somewhat difficult for some soldiers to perform (and consequently annoying), they were, nevertheless, able to execute the scenarios and received some training benefit based on their subjective reports. The computing power issue remains a problem and will not likely be solved in the immediate future.

The behaviors listed above may also be limited by the fact that the soldier can not look in a direction other than the one he is moving, by having to move (almost) solely by the thumbstick, and inadequate look down (and up) capability, along with limited field of view. These are implementation issues that are independent of computing power.

Integration of DI-SAF into Task-Based Scenarios

Overall, the scenarios were well received by the soldiers. The biggest problem in this area, as noted by ARI observers, was the meaningful integration of DI-SAF soldiers into the actual scenarios. The "React to Contact" scenarios, while favored by the soldiers, could not be run as a true "React to Contact" drill (in the real world) using an all DI-SAF OPFOR. As noted earlier, the superior marksmanship of the DI-SAF forced the scenarios to be modified by putting the lead DI-SAF soldier (i.e., the one who would make initial line-of-sight contact with the soldiers) on "hold fire." This allowed the soldiers to locate and identify the DI-SAF OPFOR soldier, take cover, and initiate fire. Only then would the DI-SAF fire his rifle, assuming he was not already shot. If this modification was not made, then once the DI-SAF soldier made line-of-sight contact with the soldiers, he would commence firing and would have eliminated the soldiers too quickly for the drill to be executed. While this adjustment allowed the scenarios to be played out and became quite involving for the soldiers, it also changed the entire complexion of the scenario. Clearly, the marksmanship levels of the DI-SAF should be modified to approach the real world capabilities of soldiers. In addition, there should be some allowance for soldiers to

be shot and wounded. As noted in Table 15, P(Kill/Hit), the probability of a kill given a hit, should not be 1.00.

Integrating the DI-SAF with real soldiers (as was the case) for the "Assault" and the revised "Clear a Building" scenarios was also problematical. The inability for DI-SAF to respond in real time to changing battlefield conditions forced the squad leaders to restrict their roles in the scenarios. DI-SAF performance was further affected by the fact that their movement must be pre-programmed before the scenario is run. As a result, the DI-SAF fire team element was used almost exclusively in a support/security mode and played only a minimal role in the execution of the revised "Clear a Building" scenarios. For the "Assault" scenarios, the DI-SAF BLUFOR fire team and OPFOR frequently dominated the action. The team leader typically sent the DI-SAF fire team ahead of the SVS element to locate the enemy. Inevitably, they did and a fire fight ensued. The fire fight often took place so quickly that the soldiers did not have much of a chance to participate extensively in the scenario. As noted earlier, the quickness with which the DI-SAF soldiers moved in relation to the real soldiers in their SVSs, their superior marksmanship, and lack of real time responsiveness to situational contingencies, caused them to be viewed by the soldiers as "hokey" and seemed to detract from rather than enhance the training value of the scenarios. Reinforced, in part, by their participation at the actual McKenna site, soldiers felt that the training value of the simulations would be significantly upgraded by introducing a live force element to the DI-SAF OPFOR.

Scenario Revisions for Phase IB

Following the completion of Phase IA, ARI was informed that they would have the same set of soldiers for Phase IB. This required extensive revisions in the existing scenarios since the soldiers were already familiar with them, they could execute the scenarios with little difficulty, and DI- SAF OPFOR presented little challenge to the soldiers as they were employed in the Phase IA scenarios.

In addition to using the same soldiers, Phase IB would have five of the immersive SVS systems available for use in addition to the SVS desktop. This would allow all soldiers to participate at one time for any given scenario. One way of making the scenarios more challenging may be to increase the number of live BLUFOR members. Another possibility would be to vary the roles of the DI-SAF. Instead of positioning them in one location or locations close together, they could be placed in geographically more diverse areas. The DI-SAF OPFOR could also be more aggressive in their actions and initiate contact (sniper, crossfire, ambush) as soldiers moved en route to their objectives. Finally, some soldiers could be moved to the OPFOR side and integrated with DI-SAF OPFOR soldiers to provide live force-on-force capability.

Phase IB addresses these scenario revisions. Key modifications are detailed along with results from the soldier evaluations and possible implications for future STO work.

PHASE IB
EVALUATION OF REVISED SOLDIER AND SMALL UNIT LEADER TRAINING SCENARIOS

Method

Materials

Post Experiment Questionnaire. The Post Experiment Questionnaire (Appendix I) was a multiple choice/short answer paper-and-pencil instrument filled out by soldiers after the completion of all revised scenarios for Phase IB. The questionnaire consisted of items designed to tap the training value of each scenario, determine additional tasks that could be cost-effectively trained using simulations, soldier preference for DI-SAF versus live force-on-force scenarios, needed DI-SAF capabilities, critical scenario content areas, what soldiers liked most/least about the scenarios, use of scenarios to practice decision-making skills, and desired feedback features.

Development of Revised Soldier and Small Unit Leader Training Scenarios

Based on observations and soldier feedback, two sets of task-based scenarios were selected for revision. These were "Clear a Building" and "React to Contact." The scenarios were modified across a number of areas. The most obvious area was in the number of soldiers participating in each scenario. As mentioned earlier, all six soldiers were able to participate in each scenario with the addition of three immersive SVS systems (five total immersive systems plus the SVS desktop).

For the "Clear the Building" scenarios, the DI-SAF OPFOR were more aggressively employed. In one scenario, as the soldiers were approaching the building to be cleared they were exposed to fire from a single sniper. For the second scenario, as the soldiers were approaching the building, they were caught in a crossfire from two DI-SAF OPFOR snipers. In the third scenario, soldiers were allowed to enter the building and then two DI-SF OPFOR followed them into the building to ambush them. Soldiers surviving these initial engagements were then required to clear the building. The last scenario for this task involved a force-on-force encounter. Two soldiers were selected to play the OPFOR role. They were allowed to position themselves anywhere within or outside the target building along with one DI-SAF OPFOR. The tactical approach employed was left for the soldiers to decide. They were only told what direction the BLUFOR was coming from and that they would be clearing the target building occupied by the OPFOR.

In each scenario soldiers approached the building from different directions. Due to system constraints, DI-SAF could only move, see, and shoot from the inside of one building. Thus, scenarios were based around this particular building. Scenarios were altered slightly by having soldiers enter different areas of the building complex and positioning the DI-SAF in different rooms or locations inside the building.

Four scenarios were also constructed for the "React to Contact" task. The scenario structure was similar to the "Clear a Building" scenarios but without the "Clear a Building" phase formally crafted into the scenario. Soldiers moved from three different points in the city to specific locations. En route, they encountered fire from the DI-SAF OPFOR. The fourth scenario involved a live force-on-force encounter with two soldiers playing the OPFOR role along with 2-3 DI-SAF.

Another set of scenarios was also crafted. These scenarios were called mixed squad scenarios since they involved a full squad of BLUFOR composed of the six SVS systems and a four-man DI-SAF fire team. Three scenarios were developed. All involved clearing the same building as they had done earlier. Scenarios were modified to have soldiers approaching the building from different locations, entering different areas of the building, and positioning the DI-SAF in different rooms/areas of the building. For the first two scenarios, soldiers encountered sniper fire from one or two DI-SAF OPFOR en route to the targeted building. For the third scenario, soldiers were allowed to get close to the target building where two to three DI-SAF soldiers would begin firing at them from different locations outside the building.

Due to the way DI-SAF is currently configured, the BLUFOR squad leader had to develop his movement plans for his four-man DI-SAF fire team the day before the actual scenarios were executed. This was necessary so the SAF operator had enough time to pre-program the movement patterns of the DI-SAF fire team for each scenario.

Maps of the McKenna training site were provided to the team/squad leader. For the "Clear a Building" scenarios the maps showed the direction the team/squad would take and the specific part of the target building to clear, e.g., which door to enter and floors to clear. For the "React to Contact" scenarios, the maps showed the team's/squad's location and the direction they would be moving.

Design and Procedure

Since the same soldiers were used as in Phase IA, three weeks earlier, no additional training time was provided. Soldiers were already quite familiar with the SVS system and its operation. The experimental phase lasted approximately two days. Soldiers were scheduled to run all "Clear a Building" and the "React to Contact" scenarios on day one. The "Clear a Building" scenarios were run first. For the first three scenarios soldiers operated as a six-man team against an all DI-SAF OPFOR. The force-on-force scenario required splitting the team into two elements, a four-man BLUFOR and a two-man OPFOR with an additional DI-SAF OPFOR soldier. Both the BLUFOR and OPFOR were informed (separately) what they would be doing and given time to plan. (This was done for all force-on-force scenarios.)

Only two of the four "React to Contact" scenarios were run. After one of the three live (six-man SVS configuration) BLUFOR versus DI-SAF OPFOR scenarios were run, the remaining two were canceled. This was done for several reasons. First, it was obvious that the soldiers remembered from the "Clear a Building" scenarios where the snipers were positioned and the best way to approach their location. This minimized the surprise element. Due to the set up and the size of the city, there were few choices on where to position the snipers for maximum

effectiveness. Consequently, the snipers were not moved. In addition, the SAF operator could not move the snipers from their original position in a timely fashion that would allow the scenario to play out without interruption. The lack of responsiveness of the DI-SAF snipers to real time changes in the scenario (presence of soldiers approaching the snipers) took away much of the challenge these DI-SAF afforded to the BLUFOR.

The following day the mixed squad scenarios were run. Only the first two scenarios were run. Although these scenarios were expected to be the most challenging, in actuality this was not the case. The lack of responsiveness (to immediate changes in events) of the DI-SAF BLUFOR fire team resulted in the squad leader using the team primarily for fire support. They would be moved to a location away from the other soldiers and were utilized at times as an afterthought. The squad leader had to be reminded by the SAF operator to involve these elements in the operation. Soldiers were also familiar with the likely locations of incoming sniper fire and were able to effectively neutralize this threat.

Once inside the building, the DI-SAF OPFOR proved to be no match for the soldiers. This was due either to their slowness in moving into (firing) position or their reduced marksmanship capability. In any event, the DI-SAF did not present much of a challenge to the BLUFOR.

As a result, immediate modifications were made on site at the LWTB. One of the soldiers was recruited to play the role of a roaming OPFOR sniper using the SVS desktop system. All other aspects of the scenario remained the same. The sniper was free to use any building to fire from and to move as he saw fit. This resulted in an immediate increase in soldier motivation, and concentration. The first time the scenario was run, the sniper killed all the BLUFOR. After a short break, the scenario was run again. This time, while BLUFOR casualties were taken, the surviving BLUFOR members were able to locate and neutralize the sniper.

After the second run of the roaming sniper scenario, the experimental phase was terminated. Soldiers then completed the Post Experiment Questionnaire.

Results

Subjective Assessments of Small Unit Scenarios

Soldiers responses to the Post Experiment Questionnaire are summarized below. The major focus of the questionnaire was to determine the potential training value of the scenarios and needed modifications.

Which scenarios provided the most training value? Soldiers were unanimous in their feelings that the "React to Contact" force-on-force scenario provided the most training value. This was followed by "Clear a Building" force-on-force scenario. The "Clear a Building" scenarios with the single or multiple (DI-SAF) snipers and with DI-SAF OPFOR following the BLUFOR into the building were the next most frequently selected scenarios (selected by fifty percent of the soldiers). The combination DI-SAF/live squad scenarios fell into this last

category. The fact that these scenarios were selected at all could probably be attributed to the introduction of the roaming live sniper.

The scenario possessing the least training value for the soldiers was the "React to Contact" scenario with DI-SAF OPFOR snipers. Lack of responsiveness of the DI-SAF and the fact that the sniper element was introduced in the earlier "Clear a Building" scenarios minimized the surprise factor. Also, as noted earlier, the soldiers were familiar with the likely location of the snipers from the earlier scenarios. This made it relatively easy to locate the snipers and neutralize them.

When asked to explain why they selected these particular scenarios they indicated that these were the scenarios that they trained on the most. The live force-on-force scenarios (with some DI-SAF) were the most preferred scenarios because of the unpredictable nature of the live OPFOR. Soldiers liked testing their skills against a human OPFOR with similar mental capabilities. Similarly, they preferred a live OPFOR because they are able to move and react immediately to what soldiers in the SVSs do. This makes the scenarios more challenging. None of the soldiers preferred scenarios involving DI-SAF only over the combined live force-on-force DI-SAF scenarios.

Soldiers were also asked what other tasks could be cost-effectively trained using simulations. Several mentioned "Assault" and "Assault in a Woodland Area." As one soldier noted, any task that involved contact with the enemy would provide some training value (and presumably could be cost-effectively trained using simulations) to the small unit (team/squad) member or leader.

Improving DI-SAF capabilities. For DI-SAF to be more effective from a training standpoint, according to the soldiers, the DI-SAF must be more dynamic in their actions. To have any kind of impact, DI-SAF must be able to react to what is going around them at the moment. This is the major reason they were so under utilized in the scenarios.

Scenario content for small unit (fire team/squad) level training. According to most soldiers, to be effective for small unit level training the scenarios should stress team coordination and communication. One soldier indicated that the scenarios should stress shooting, moving, and communication. Another soldier felt that effective small unit training scenarios should stress unit SOPs (ways to clear rooms, moving from room to room, security and assault).

What soldiers liked most about the scenarios. One aspect of the scenarios that the soldiers liked was the emphasis placed on thinking and planning. For example, the placement of team/squad members, movement through the city and from building to building, establishing sectors of fire/covering fire and overwatch positions, and location of snipers. The scenarios were constantly changing depending on the route soldiers took through the city, number of team members available, the presence or absence of the team/squad leader, etc. This required the soldiers to be able to quickly plan and modify plans according to the situation. Soldiers also liked the fact that the scenarios offered potential solutions for similar real world situations by allowing different courses action to be developed and played out (safely) in the simulations.

What soldiers liked least about the scenarios. Everything the soldiers disliked about the scenarios was system related. For example, the soldiers did not like being killed while they (their avatars) were frozen, or stuck in walls. Aspects of clearing buildings were made more difficult/unrealistic because of the limited field-of-view provided by the head-set and problems maneuvering inside of buildings, particularly when moving over and around dead people. In some instances the system was too good. For example, the team/squad leader had perfect communication with all team/squad members. This would almost never be true in the real world where communications would be degraded and or lost at different times for different team/squad members. Nevertheless, the increased communication capability was critical if the scenarios were to be run using the current simulation system, since soldiers could not use hand-and-arm signals.

Utility of scenarios for practicing decision-making skills. Feedback from Phase IA indicated that the simulations could be used to develop decision-making skills. One question from Phase IB asked specifically whether the scenarios developed for this phase could be effectively used to practice decision-making skills. All soldiers answered yes. For the more dynamic scenarios the fluid situations required the soldiers, particularly the team/squad leader, to constantly assess the situation and plan the team or squad's actions. If the leader was killed then another soldier had to assume the leadership position. Thus, all soldiers had to be alert to changing aspects of the scenarios. For these reasons, some soldiers felt these scenarios would be helpful in preparing for similar, real world situations.

Desired feedback features. For maximum training effectiveness, the scenarios must be followed by some type of feedback. Soldiers were unanimous in this regard. Once a scenario was completed the soldiers would often come together and conduct their own after action review. When asked what type of feedback they would find most useful, soldiers mentioned movement patterns (of the soldiers), round counts and hit percentage for fire control/distribution purposes, number of OPFOR/BLUFOR killed, and decision points where fatal mistakes were made.

General Observations

Soldier performance was observed by three ARI researchers. Critical incidents from the scenarios were recorded. These observations are summarized in the following sections.

System malfunctions. The frequency of system malfunctions increased noticeably for Phase IA to IB. The biggest problem appeared as soldiers (avatars) were in the assembly area preparing for the scenario. A number of soldiers appeared to be in quicksand as they quickly sunk up to their armpits and could not get out. In other instances soldiers would levitate in the air. This was observed in the north part of the McKenna data base and the south end as well. This appeared to be a result of "holes" in the data base. This phenomenon was not observed in Phase IA.

Another system problem that was touched on earlier was the difficulty soldiers had moving around dead bodies in buildings. Soldiers appeared to get stuck every time they attempted to step around or over the bodies. Also when inside buildings, DI-SAF OPFOR who

were killed would occasionally vaporize, only to reappear unexpectedly sometime later and shoot the BLUFOR soldier.

Another movement related problem noted by all soldiers was the difficulty in looking left or right, for example, while moving across the street. The system did not permit the soldier to turn his head as he would in the real world. This became a critical problem with snipers firing at the soldiers.

SVSs were observed to "freeze" a number of times. This seemed to be related to the increased use of DI-SAF in the scenarios for Phase IB. If the SAF operator attempted to move or reposition the DI-SAF to put them in better tactical positions, this would cause the soldiers' avatars to "freeze" in the virtual world while the computer updated the position of the SAF elements. In a few instances this resulted in the live soldiers being shot if they happened to freeze in a vulnerable position. This was a source of significant frustration for those affected.

Other system problems that were observed included soldiers' inability to localize sounds (shots from weapons) and inaccuracy of sniper fire. In one instance, the DI-SAF sniper fired over thirty times without hitting anything. Apparently, the sniper could see the BLUFOR soldiers but could not adjust his angle of fire.

DI-SAF and the "hokey" factor. As noted earlier, the lack of DI-SAF responsiveness to immediate changes in battlefield conditions was a major problem from the soldiers' standpoint and was a major reason for their under utilization. In general, the presence of DI-SAF lead to an apparent increase in the "hokey" factor, which resulted in two tendencies. First, general tactical techniques employed by the BLUFOR deteriorated (due in part to BLUFOR knowing the likely location of the DI-SAF OPFOR from prior scenarios). Second, the DI-SAF BLUFOR were typically positioned in out of the way locations by the squad leader, then were immediately forgotten, while the live BLUFOR completed the mission. When employed in a more active role in the mission (assigned to the point position) the SAF completed the mission before the live BLUFOR could get involved. In this last instance, their unrealistic responsiveness (i.e., they moved too quickly) diluted the realistic aspects of some of the scenarios. Overall, it appeared that the DI-SAF are an unnecessary distraction, or source of frustration, that contributes very little to overall realism of the virtual world.

BLUFOR familiarity with the database. The soldiers were completely familiar with the data base, to the point that they knew where the OPFOR was likely to be, and where they would not be. Therefore, they were able to enter most buildings with little concern for personal safety and ignored tactical protocol (for clearing rooms) including tactical communication. Tactics improved somewhat when the BLUFOR were in an area that was high risk for enemy contact, and improved markedly when faced with a live fire sniper.

Makeup of BLUFOR team. The BLUFOR team was composed entirely of E-5s. This was done deliberately for this pilot investigation to get experienced soldier feedback on varying aspects of the scenarios and the SVS system itself. Nevertheless, the composition of the team impacted on how the scenarios were executed. With only leaders in the scenarios, more independent decision-making was observed on the part of all the participants, without them

needing to be told where to go and what to do. The behavior, and general interaction patterns of the team would most likely change with a more conventionally organized (rank-wise) team.

Implications for Future STO Research (FY 99)

The major objective of the STO Phase IA and IB research was to use the high payoff tasks identified earlier as the framework for developing small unit training scenarios for use in virtual environments with the SVS. Once the scenarios were developed, each would be evaluated by soldiers and researchers for their strengths, weaknesses, and potential training value. The best scenarios would then be used during the Phase V evaluation. The following sections summarize the major lessons learned from this research as it applies to Phase V.

General structure of scenarios. As mentioned earlier, the most effective scenarios, from a training standpoint, appear to be those which include a combination of tasks such as tactical movement, reconnaissance and enemy contact. The enemy contact can be through "React to Contact," "Assault" or "Clear a Building."

Observations suggested that for the more complex tasks such as "Clear a Building", it may be better to let soldiers perform the additional tasks of movement and reconnaissance (which the soldiers did) as part of the total scenario. It was initially assumed that for the "Clear a Building" scenarios, soldiers would simply move to the target building and clear it without concern for movement techniques or the need to conduct any reconnaissance since these tasks were not the focus of the scenario.

However soldiers took the entire scenario seriously, to include moving to the building and conducting the appropriate reconnaissance activities which were performed in a tactically sound manner. These "preparatory tasks" allowed the soldiers the time to immerse themselves more completely into the scenario. The idea of pre-positioning soldiers to the exact spot where contact was expected was initially considered (and rejected) as a way to shorten the run-times of the scenarios which were lasting much longer than anticipated. Soldiers should be allowed to play out the scenario as it would most likely occur in the real world, i.e., movement up to the objective, reconnaissance, mission execution (clear a building, assault), report.

Incorporating DI-SAF into scenarios. Based on current technological limitations, DI-SAF is clearly less effective than live soldiers in simulators for mission training and rehearsal. An all DI-SAF OPFOR (with the possible exception of the first run "sniper-Clear a Building" scenarios) provided little challenge to the soldiers. Observations from Phase IB showed that adding one soldier to the OPFOR to act as a roaming sniper significantly increased the soldier motivation in the scenarios, due to the challenge of going against a real person with similar tactical skills and capable of quick, and sometime unpredictable actions.

Increasing technical support. The increased number of system malfunctions observed from Phase IA to IB which were observed as more SVS systems were put "on-line" (going from two to five SVSs) significantly increased the workload of the technicians in charge of calibrating and troubleshooting system problems. It also increased the amount of down time experienced by soldiers and tended to dilute soldier involvement and motivation. With all nine SVSs scheduled

for use during parts of Phase V, additional technical support should be considered to minimize long periods of idleness and frustration for both the researchers and soldiers.

It was also clear from observations in Phase IB that multiple DI-SAF operators are needed, one for the BLUFOR and one for the OPFOR. There is clearly no way one operator can simultaneously focus on the actions of two opposing elements. Typically, what was observed, was if the SAF operator was manipulating the DI-SAF OPFOR, then the DI-SAF BLUFOR would be ignored, and vice versa. To reduce delays and improve mission integrity, two operators are required: one to focus entirely on DI-SAF BLUFOR actions and another responsible for only DI-SAF OPFOR behavior.

Conclusion

Overall, soldiers had few complaints concerning the selection or make-up of the task-based scenarios. The majority of scenario-related problems that were observed were system or design-based, e. g., getting stuck in walls, being shot while "frozen," appropriate movement and posturing of avatars, moving around dead bodies inside of buildings, lack of DI-SAF responsiveness to immediate changes in the scenario, limited field-of-view of the projection display, positioning of the microphone on the head set. A key to enhancing the training value of the scenarios is to ensure that the OPFOR is composed of at least one real soldier. The live force-on-force scenarios were seen as very challenging by the soldiers.

Although the issue was not specifically assessed, soldiers said that prior participation in the simulations helped their performance in the real world by reducing their planning time in the field and mentally preparing them for what to expect when faced with similar situations in the field. The task-based scenarios were seen as useful since they addressed the actual real-world tasks and missions that the soldiers most frequently train on in their units.

Soldiers felt that simulators, specifically, the SVS systems, could be used to enhance small unit training. The systems can be used to practice coordination between team members, develop communication skills and refine SOPs. They also felt this technology can be used for mission rehearsal activities. Finally, soldiers thought that the more dynamic scenarios portrayed on the SVSs could be effectively used to practice and sharpen decision-making skills.

Implications for Future Research

The next year of the current STO work program will continue to focus on the training potential of improved Infantry simulation technologies as they impact on the SVS and the squad synthetic environment as a whole. Based on the findings from Phase IA and IB, ARI-Fort Benning will conduct a more focused investigation on the use of this simulation technology to enhance the decision-making skills of soldiers and small unit leaders. The work effort will be divided into two parts. One part will involve leveraging available SVS technologies to effectively train soldiers on specific cognitive aspects of the decision-making process, e.g., environmental cues, tactical factors. The other part will focus on improving the capabilities to measure leader and squad performance. A methodology is envisioned that will allow the trainer to identify critical training/decision points in the virtual scenario. Points will include

environmental cues the soldier needs to notice and interpret and tactical factors that must be taken into account when the soldier makes decisions and employs strategies. The soldier's behaviors, decisions and judgments will be tracked at these critical pre-determined points. In addition, the process will track mission related factors such as rounds fired, casualties, time to complete the mission, soldier movement patterns, etc. and provide relevant summary statistics and feedback following the completion of each scenario. This procedure will also be able to link these factors with the soldier's decisions or behaviors at pre-determined points. An evaluation of the entire training approach will be conducted. The work just described will address the major objective of the current STO program, namely to provide effective methods for the use of virtual environment technology to prepare soldiers and small unit leaders for the conduct of urban and contingency operations through improved training and/or mission rehearsal.

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Appendix A

Jacobs et al. (1994) Original Task List Annotated for Selection

Assault	Linkup	React to Nuclear Strike
Move Tactically	Infiltrate / Exfiltrate	Operate in NBC Environment
Reconnoiter Area	Helicopter Movement	Chem./Bio Decontamination
React to Contact	Boat Movement	Radiological Decontamination
Clear Building	Prepare for Chemical Attack	Infiltrate Area by Land
Hasty Ambush	Prepare for Nuclear Attack	Establish Contact With Asset
Defend Built Up Area	Cross Chem. Contaminated Area	Move In Denied Area
Overwatch	Cross Nucl. Contaminated Area	Establish Mission Support Site
Disengage	Cross Water Obstacle	Establish Surveillance Site
Cross Danger Area	Maintain Op. Security	Send Information by Radio
Knock Out Bunker	Defend – Air Attack	Prepare for Exfiltration
Occupy OP / Surveil	Aerial Resupply	Exfiltrate by Land
Breach Obstacle	Sustain	Exfiltrate by Water
Clear Trench Line	Prepare for Combat	Exfiltrate by Air
Antiarmor Ambush	Consolidate and Reorganize	Confirm Operation Plan
Point Ambush	Infiltrate by Air	Interdict a Target
Defend	Infiltrate by Water	Conduct Recovery Operations
Occupy Assembly Area	Conduct Assembly	Break contact
Passage of Lines	Control Info Dissemination	React to Ambush
Clear Wood Line	Employ Countermeasures	React to Indirect Fire
Occupy Objective / Rally Point	Prepare for NBC Operations	React to Chemical Attack
Occupy Patrol Base	React to Chem. or Bio Attack	React to Nuclear Attack
Stay Behind		

Note: Tasks are grouped by feasibility for use with current or near term SVS simulator technology. Items in bold type were selected as most probably useful. Items in italics were considered initially, but later judged as inappropriate for use in the small unit leader training scenarios. The remainder of the items were judged as not cost effective and/or feasible.

Appendix B

Lockheed Martin (1997) Modified Task List Annotated for Selection

Execute Assault	Engage Targets w/ M203 Using NVS
Battle Drill 6A Enter Bldg, Clear Room (Squad)	Restore M49 Antitank Weapon to Carrying Config.
Move as Member of Fire Team	Operate NVS AN/TAS-5
Control Movement of a Fire Team	Engage Targets w/ M47 Medium Antitank Weapon
Move Dismounted	Prepare an M47 Medium Antitank Weapon for Firing
Reconnoiter Objective	Perform Misfire Procedures on M47
Report Info of Potential Intelligence Value	Lay M60 Machine Gun Using Field Expedients
Reconnoiter Area	Prepare Range Card for M60 Machine Gun
Move Tactically	Engage Targets using M60 w/ NVS AN/PVS-4
Battle Drill 2 React to Contact (Platoon/Squad)	Zero NVS AN/PVS-4 to M60 Machine Gun
Perform Movement Techniques During MOUT	Restore M136 Launcher to Carrying Configuration
Engage Targets w/ M16A1 or M16A2 Rifle	Perform Misfire Procedures on M136 Launcher
Perform Overwatch/Support by Fire	Operate Night Vision Sight AN/PVS-4
Perform Hasty Ambush	Operate Night Vision Goggles AN/PVS-5
Defend MOUT/Building	Operate Thermal Viewer AN/PAS-7
Adjust Indirect Fire	Battle Drill 1A Squad Attack
Prepare/Submit NBC 4 Reports	Battle Drill 3 Break Contact (Platoon/Squad)
Transmit Voice USMTF Message	Guide Helicopter to a Landing Point
Conduct Unmasking Procedure	Encode and Decode Messages Using KTC 600
Prepare/Submit NBC 1 Reports	Clear a Misfire
Install Hot Loop	Prepare Platoon Early Warning System AN/TRS-2
Operate Telephone Set TA-312/PT	Issue an Oral Operation Order
Recover Mechanical Ambush	Move as Member of M2 BFV Rifle Team
Install Mechanical Ambush	Execute Attack
Operate M9 Pistol	Perform Voice Communications
Engage Targets with M249 Machine Gun	Protect Self from Bio/Chem Injury w/ Prot. Mask
Lay M249 Machine Gun Using Field Expedients	Perform Antiarmor Ambush
Operate M249 Machine gun	Orient a Map Using Lensatic Compass
Construct Firing Aids for M16A1 or M16A2	Perform Actions in Danger Areas
Zero Night Vision Sight for M16A1 or M16A2	Defend Against Air Attack
Engage Target with M16A1 or M16A2 w/ NVS	Perform Function Check on M16A1 or M16A2
Const. Firing Aid for M203 Grenade Launcher	Load M16A1 or M16A2 Rifle
Zero NVS to M203 Grenade Launcher	Battle Drill 4 React to Ambush (Platoon/Squad)

Note: Tasks are grouped by feasibility for use with current or near term SVS simulator technology. Items in bold type were selected as most probably useful. Items in italics were considered initially, but later judged as inappropriate for use in the small unit leader training scenarios. The remainder of the items were judged as not cost effective and/or feasible.

Lockheed Martin (1997) Modified Task List Annotated for Selection (Continued)

Battle Drill 5A Knock Out Bunker (Squad)	Measure Distance on Map
Battle Drill 7A Enter/Clear Trench (Squad)	Perform Surveillance w/o Electronic Devices
Unload M16A1 or M16A2 Rifle	Lay M60 Machine Gun w/ Field Expedients
Obtain Magnetic Azimuth w/ Lensatic Compass	Prepare Range Card for M60 Machine Gun
Engage Targets with M60 Machine Gun	Perform Function Check on M60 Machine Gun
React to Flares	Employ Hand Grenades
Protect From NBC Injury w/ MOPP Gear	Employ M18A1 Claymore Mine
Locate Target by Grid Coordinates	Move Under Direct Fire
Prepare M136 Launcher for Firing	React to Indirect Fire While Dismounted
Use KTC-600 Numerical Cipher/Auth. System	React to Nuclear Hazard
Locate Target by Shift from Known Point	React to Biological or Chemical Attack/Hazard
Control Organic Fires	Evaluate a Casualty
Issue a Warning Order	Report Casualties
Conduct Troop Leading Procedures for Operation	Request Medical Evacuation
Install. Planning/Install. of Platoon EWS	Report Explosive Hazard
Conduct Maneuver of M2 BFV Rifle Team	Use M256 or M256A Chemical Agent Detector
Execute Disengagement	Receive Voice USMTF Message
Perform Point Ambush	Conduct Breach of Minefield
Execute Defense	Conduct Defense by a Squad
Occupy Assembly Area	Consolidate Squad Following Enemy Contact
Load M60 Machine Gun	Reorganize Squad Following Enemy Contact
Unload M60 Machine Gun	Direct Unit Air Defense
Locate Unknown Point on Map/Grnd by Intersect.	Implement Mission-Oriented Protective Posture
Perform Linkup	Install/Recover Communications Wire Lines
Perform Infiltration/Exfiltration	Mark NBC Contaminated Area
Perform Relief Operations	Challenge Persons Entering Your Area
Perform Passage of Lines	Prepare Positions for Crew-Served Weapons in MOUT
Perform Surveillance from Observation Post	Monitor Platoon Early Warning System AN/TRS-2
Consolidate and Reorganize	Issue Fragmentary Order
Estimate Range (Sniper)	Select Hasty Firing Positions During MOUT
Provide Guides (Scout)	Conduct Maneuver of Squad
Recover M18A1 Claymore Mine	Conduct Leader's Reconnaissance
Determine Location on Ground by Terrain Assoc.	Prepare an M2 BFV Rifle Team Sector Sketch

Note: Tasks are grouped by feasibility for use with current or near term SVS simulator technology. Items in bold type were selected as most probably useful. Items in italics were considered initially, but later judged as inappropriate for use in the small unit leader training scenarios. The remainder of the items were judged as not cost effective and/or feasible.

Appendix C

Biographical Information Questionnaire

Name_____ Unit (include plt) _____

Please fill in the blank or mark or circle the appropriate response.

1. What is your age? _____ Years

2. MOS _____

3. Rank _____

4. Time in service: Years _____ Months _____

5. What is your current duty position? _____ How long in this position ? _____

6. What Army training courses have you completed? Check all that apply.

___ OSUT/AIT _____ PLDC _____BNCOC ____BFV Leader Course

___ Airborne _____ Ranger ____ Air Assault ____Combat Life Saver Course

___ Other (please specify)

7. How susceptible to motion or car sickness do you feel you are?

0	1	2	3	4	5	6	7
not susceptible	very mildly			average			very highly

8. Do you have normal or corrected to normal 20/20 vision? yes no

9. Are you color blind? Yes No

10. Are you ___ right handed? ___ left handed?

11. My level of confidence in using computers is

1 2 3 4 5
low average high

12. How many hours per week do you use computers? _____ hours per week

13. How many times in the last year have you experienced a virtual reality game or entertainment?

0 1 2 3 4 5 6 7 8 9 10 11 12+

14. How often have you trained at the McKenna MOUT site since basic training (not including demos)?

___ not since basic training ___ 1-3 times ___ more than 3 times

15. Have you ever participated in close quarter combat (room clearing) training EXCEPT for a demo?

Yes No

16. Have you ever participated in a demo at the McKenna MOUT site?

Yes No

17. Have you ever been in a Virtual Individual Combatant (VIC) simulator at the Land Warrior Test Bed before?

Yes No

If YES, which one(s)? (Describe if you cannot remember the name)

18. Have you had any <u>other</u> experience with military computer simulations?

Yes No

If yes, please describe briefly or give the names of the simulators.

Appendix D

SIMULATOR CAPABILITY QUESTIONNAIRE MOVE THROUGH BUILT-UP AREA: PLEASE RATE YOUR ABILITY TO PERFORM EACH TASK IN THE SIMULATOR.	VERY GOOD	GOOD	POOR	VERY POOR
1. Move through open areas as a widely separated group.				
2. Move according to directions.				
3. Maneuver around obstacles.				
4. Move in single file				
5. Maneuver below windows.				
6. Maneuver close to others.				
7. Determine other team members' positions.				
8. Maintain position relative to other team member.				
9. Maneuver around corners.				
10. Locate assigned areas of observation, e.g. across the street.				
11. Look around corners.				

SIMULATOR CAPABILITY QUESTIONNAIRE RECONNOITER AREA: PLEASE RATE YOUR ABILITY TO PERFORM EACH TASK IN THE SIMULATOR.	VERY GOOD	GOOD	POOR	VERY POOR
1. Execute planned route.				
2. Identify assigned sectors of observation.				
3. Maintain position relative to other team members.				
4. Look around corners.				
5. Move close to walls.				
6. Scan from side to side.				
7. Scan vertically.				
8. Identify civilians.				
9. Identify enemy soldiers.				
10. Identify potential danger points.				
11. Estimate distances from self to a distant object.				
12. Communicate spot reports to squad leader.				

SIMULATOR CAPABILITY QUESTIONNAIRE REACT TO CONTACT: PLEASE RATE YOUR ABILITY TO PERFORM EACH TASK IN THE SIMULATOR:	VERY GOOD	GOOD	POOR	VERY POOR
1. Visually locate the source of enemy fire.				
2. Determine the source of enemy fire by sound.				
3. Distinguish between friendly and enemy fire.				
4. Identify civilians.				
5. Communicate enemy location to team member.				
6. Take hasty defensive positions.				
7. Aim weapon.				
8. Fire weapon in short bursts.				
9. Fire weapon accurately.				

SIMULATOR CAPABILITY QUESTIONNAIRE ASSAULT: PLEASE RATE YOUR ABILITY TO PERFORM EACH TASK IN THE SIMULATOR.	VERY GOOD	GOOD	POOR	VERY POOR
1. Identify covered and concealed routes.				
2. Identify areas that mask supporting fires.				
3. Coordinate with other squad members.				
4. Execute the assault as planned.				
5. Move quickly to the point of attack.				
6. Assume defensive positions.				
7. Identify safe and danger areas.				
8. Locate support team positions.				
9. Locate buddy team firing positions.				

SIMULATOR CAPABILITY QUESTIONNAIRE CLEAR A BUILDING: PLEASE RATE YOUR ABILITY TO PERFORM EACH TASK IN THE SIMULATOR.	VERY GOOD	GOOD	POOR	VERY POOR
1. Take position to one side of a doorway.				
2. Move quickly through doorways.				
3. Take a tactical position within a room.				
4. Scan the room quickly for hostile combatants.				
5. Engage targets within a room.				
6. Identify non-combatants within a room.				
7. Move past furniture in a room.				
8. Maneuver past other personnel within a room.				
9. Understand verbal commands.				
10. Identify sector of responsibility.				
11. Communicate spot reports to squad leader.				

Appendix E

Simulator Capability Questionnaire (Part 2) Name_____

1. How did your participation in the simulation affect your performance in the MOUT site exercises?

a) Improved my performance.
b) Had no affect on my performance.
c) Hurt my performance.
d) Don't know.

Please briefly explain your answer:

2. What part of the simulation did you consider most realistic?

3. What part of the simulation did you consider least realistic?

4. List any aspects of the Virtual Individual Combatant simulator that you found distracting.

5. Do you feel the simulator is or could be a useful tool for mission rehearsal? Why, or why not?

6. Do you feel the simulator is or could be a useful tool for MOUT training? Why, or why not?

7. Did any prior simulation or computer experience affect your performance? If so, indicate which and explain why, or why not?

Appendix F

Move Through Built-Up Area

Vignette # 1	Yes	No
1. Did soldiers move in single file?		
2. Were they able to maintain position relative to each other?		
3. Were tactical movement techniques employed, e.g. hug buildings		
4. Did soldiers move below windows?		
5. Did they look around corners correctly (or verbalize correct way)?		
6. Were all civilians and vehicles identified? (Check each one)		
Bldg. A – 1st floor office		
2nd floor office		
Bldg. L – 1st floor doorway		
Outside rear		
West End of town – Tanks		
Bldg. G – Outside		
7. Did they cross the street as a dispersed group at the intersection?		
8. Was a spot report provided to the squad leader?		
Circle all that apply: Size, Activity, Location, Unit, Time, Equipment		

Appendix F

Reconnoiter Area

Vignette # 4	Yes	No
1. Were tactical movement techniques employed, e.g. hug buildings		
2. Were all civilians/vehicles located en route to objective?		
Bldg. I – 2nd floor		
Bldg. H – 1st floor		
Bldg. J_2 – Patio (2)		
Bldg. G – BMPs (2) inside		
3. Were safe and danger areas identified?		
4.Could soldiers determine distance of buildings from their position?		
5. Did soldiers locate all enemy/vehicles at target building?		
Bldg. J_1 – Roof		
Stationary tanks (2) in rear		
Moving tank on road (1)		
6. Did they locate all enemy around adjacent building?		
Bldg. P_1 – Outside (2)		
7. Were support/firing positions identified?		
8. Were areas that might mask supporting fires identified?		
9. Was a spot report provided to the squad leader?		
Circle all that apply: Size, Activity, Location, Unit, Time, Equipment		

Appendix F

React to Contact

Vignette # 7	Yes	No
1. Were tactical movement techniques employed, e.g. hug buildings		
2. Were soldiers able to maintain position relative to one another?		
3. Did fire team take immediate cover upon receiving enemy fire?		
4. Did fire team immediately return fire?		
5. Did fire team leader use appropriate fire commands?		
(Alert, direction, description, range, method and rate of fire, commence firing)		
6. Were team members able to accurately locate enemy positions?		
Bldg. J_2 - Roof		
Bldg. G – Outside (west)		
Bldg. H - Roof		
7. Could enemy positions be located by sounds of their weapons?		
8. Did fire team leader accurately assess the situation?		
Enemy size, location, casualties, course of action		
9. Was a spot report provided to the squad leader?		
Circle all that apply: Size, Activity, Location, Unit, Time, Equipment		

Appendix F

Assault

Vignette # 10	Yes	No
1. Was a plan developed?		
2. Were support positions identified?		
3. Were areas that might mask supporting fires identified?		
4. Were firing positions identified?		
5. Were safe and danger areas identified?		
6. Was a covered and concealed route identified?		
7. Did team leader provide a spot report prior to the assault?		
8. Did squad leader check to see all elements were in position?		
9. Did squad leader effectively control suppressive fires?		
10. Was a heavy volume of fire directed at area of the objective?		
11. Did the squad leader give the order to move to the objective?		
12. Did the assault element secure the objective?		
13. Did team leader provide a spot report?		
Circle all that apply: Size, Activity, Location, Unit, Time, Equipment		
14. Was the assault executed as it was planned?		

Appendix F

Clear Building

Vignette # 13	Yes	No
1. Did team members take appropriate positions outside the doors?		
2. Were doors checked for booby traps?		
3. Were weapons held appropriately?		
4. Was verbal indication given prior to throwing grenade?		
5. Were rooms entered in a tactical manner?		
6. Did soldier scan his area and engage targets with short bursts?		
7. Did soldier use verbal command to direct next soldier into room?		
8. Were soldiers aware of their assigned sectors of fire?		
9. Were all targets in a sector engaged?		
1st floor storage room –1 enemy		
1st floor break room – 1 enemy		
10. Were civilians and enemy correctly discriminated?		
Civilians: storage room (1); 2nd floor office (4): # killed -		
11. Did soldier verbally indicate room had been cleared?		
12. Did soldier indicate room had been marked?		
13. Did team leader provide a spot report?		
Circle all that apply: Size, Activity, Location, Unit, Time, Equipment		

Appendix G

Structured Interview

Name:_____ Interviewer:_____ Date:___/___/___

1) What do you think the best use for the simulator technology could be?

2) What was the most difficult task to perform in the simulator?

3) Did you feel completely immersed in the virtual environment? How important is it to feel completely immersed?

4) What aspects of the simulator most need to be improved?

5) Were you distracted by any particular feature of the simulator?

6) Did participation in the simulation have any affect on your performance at the MOUT site? In what way?

7) If you could add any feature to the simulator's capabilities, what would it be?

8) Is there anything I forgot to ask you?

Appendix H

Move Through Built-Up Area

Team receives FRAGO and general instructions

- Route identified. Move down streets toward specified location. Soldiers move as a two-man buddy team. Soldiers assigned areas to observe across the street. Scan for enemy, civilians, and obstacles. Team members must use tactically sound movement techniques. Must provide appropriate spot reports to squad leader.
- 2-3 soldiers, 2 in VICs, 1 using Bayonet/Desk top SVS system and serving as squad leader.
- Squad leader develops plan, goes over individual responsibilities with each team member.

Team begins movement down street

- Soldiers keep distance between themselves, if possible, to 3-5 meters. Soldiers move single file along the side of the of the street, staying close to the buildings.
- When passing windows, the soldier stays below the window level and does not silhouette himself. Soldier "hugs" the side of the building. (May not be able to "hug" building, and icon may not be capable of moving below window. Soldier may have to verbalize presence of window and that he moved below it).
- Soldiers scan, stay alert for enemy/civilians in windows across the street or in doorways down the street and note obstacles. Makes spot report if appropriate.
- Soldier comes to end of block. Soldier verbally indicates awareness that weapon is not extending beyond the corner of the building. Verbalizes correct technique for looking around corner. [Lying flat on ground only exposing his head (at ground level) enough to permit observation].
- Soldiers cross street as dispersed group at the same time and proceed to destination. Continue scanning.

Operational Measures

1. Were soldiers able to maintain their relative positions with each other?
2. Were soldiers able to move in accordance with directions?
3. Did soldiers move single file?
4. Did soldiers acknowledge presence of windows and verbally indicate that they moved below the windows?

5. Did soldiers correctly identify all enemy, civilians, and obstacles?

6. Could they accurately discern the location of these individuals and obstacles?

7. Did soldier stop when he came to the end of a block and verbalize the correct way to look around corner?

8. Did soldier correctly verbalize awareness that his weapon did not extend beyond the corner of the building?

9. Did soldiers move across the street as a dispersed group at the same time?

Soldiers reach destination

- Team leader reports back to team leader that they are at destination and what they have observed.

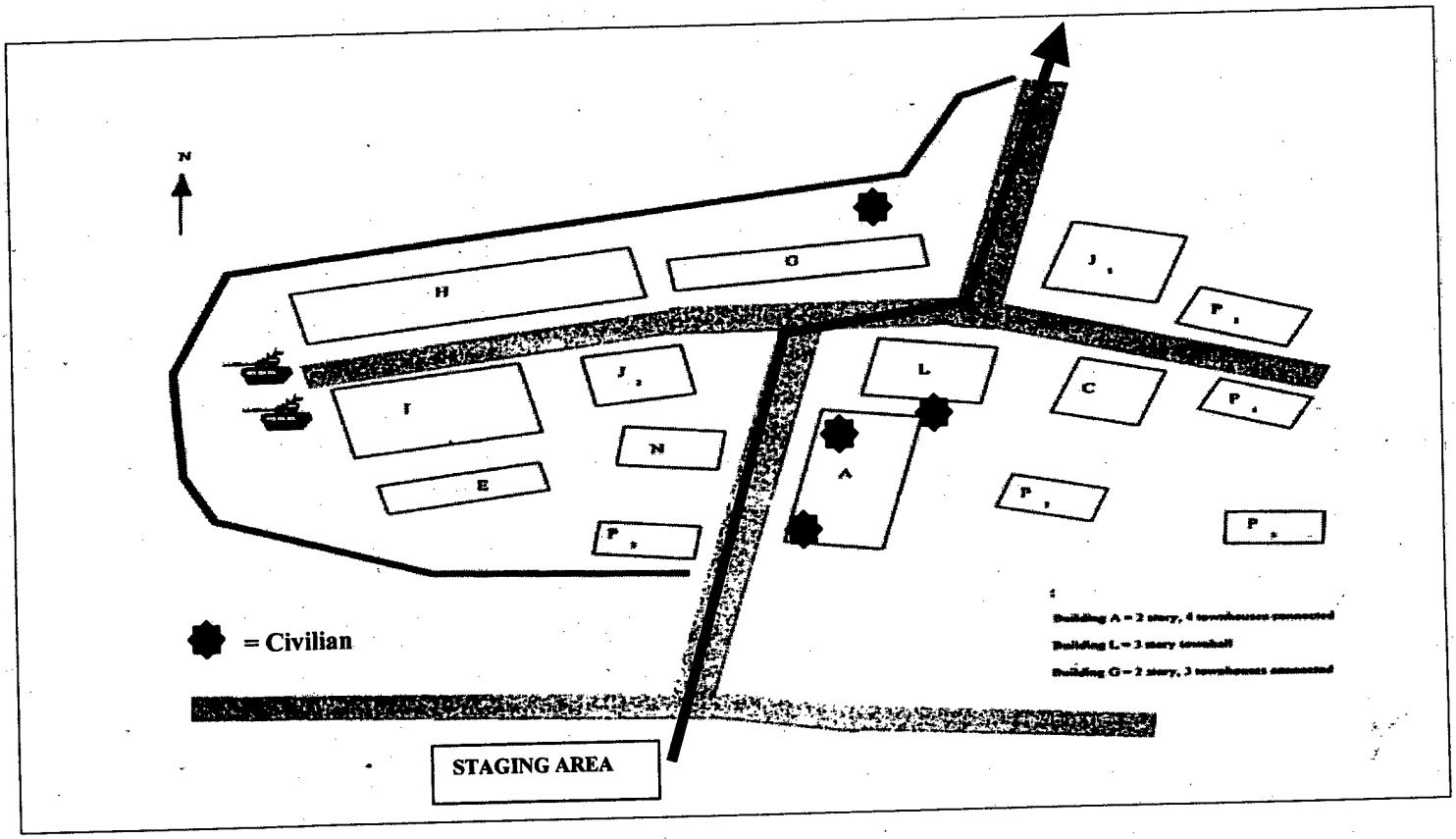
Operational Measures

1. See questions 5 and 6.

Sample Movement Scenario Map

Vignette #1
Move Through Built-Up Area
FRAGO/Instructions:

- **Squad leader develops plan, coordinates individual responsibilities of team members.**
- **Two-man team begins at south end of town, and proceeds north in a tactically sound manner.**
- **Scan for enemy, civilians, and obstacles.**
- **Provide appropriate spot reports to squad leader.**



Appendix H

Reconnoiter Area

Team receives FRAGO and general instructions

- Team moves forward along street to reconnoiter designated crossroads and building(s). Route involves one change in direction. Primary objective is second crossroad (intersection) and designated building near crossroads. Soldiers move as a two-man buddy team. Scan for enemy, civilians, and obstacles. Identify safe and danger areas. Identify areas that mask supporting fires. Estimate distance from self to a distant point. Discern location within area. Team members must use sound movement techniques. Must provide appropriate spot reports to squad leader.

- 2-3 soldiers, 2 in VICs, 1 using Bayonet/Desk top SVS system and serving as squad leader.

- Squad leader develops plan, goes over individual responsibilities with each team member

Team begins movement down the street

Note. Movement (positioning to other team member, movement around windows, at crossroads/intersection) noted but main focus is on visual identification, reporting of accurate information).

- In route to first crossroads/intersection, civilians, will appear in selected windows, door ways, top of buildings (number and location to be determined). Team leader reports back observations to squad leader.

- At first crossroads, team leader scans street and buildings for enemy and civilians. Enemy and civilians will be present. Team leader reports back number of enemy and civilians and locations, identifies safe and danger areas.

Operational Measures

1. Did soldiers correctly identify all civilians and their locations in route to the first crossroads?

2. Were soldiers able to accurately distinguish all civilians and enemy soldiers and their locations at the first crossroads?

3. Did soldiers accurately identify safe and danger areas?

Team moves to designated crossroad/building

- Team moves down street to crossroad/building without encountering enemy/civilians. At objective, enemy and civilians will be present. Team leader reports back number of enemy and civilians and locations from their position. Enemy may be in targeted building, another

adjacent building, or surrounding area. Team leader identifies safe and danger areas, support position(s) that will enable fire to be placed on enemy, and areas that mask supporting element fires.

Operational Measures

1. Were soldiers able to accurately distinguish all civilians and enemy soldiers and their locations?

2. Could soldiers accurately determine location/distance of buildings from their position?

3. Could soldiers accurately identify safe and danger areas?

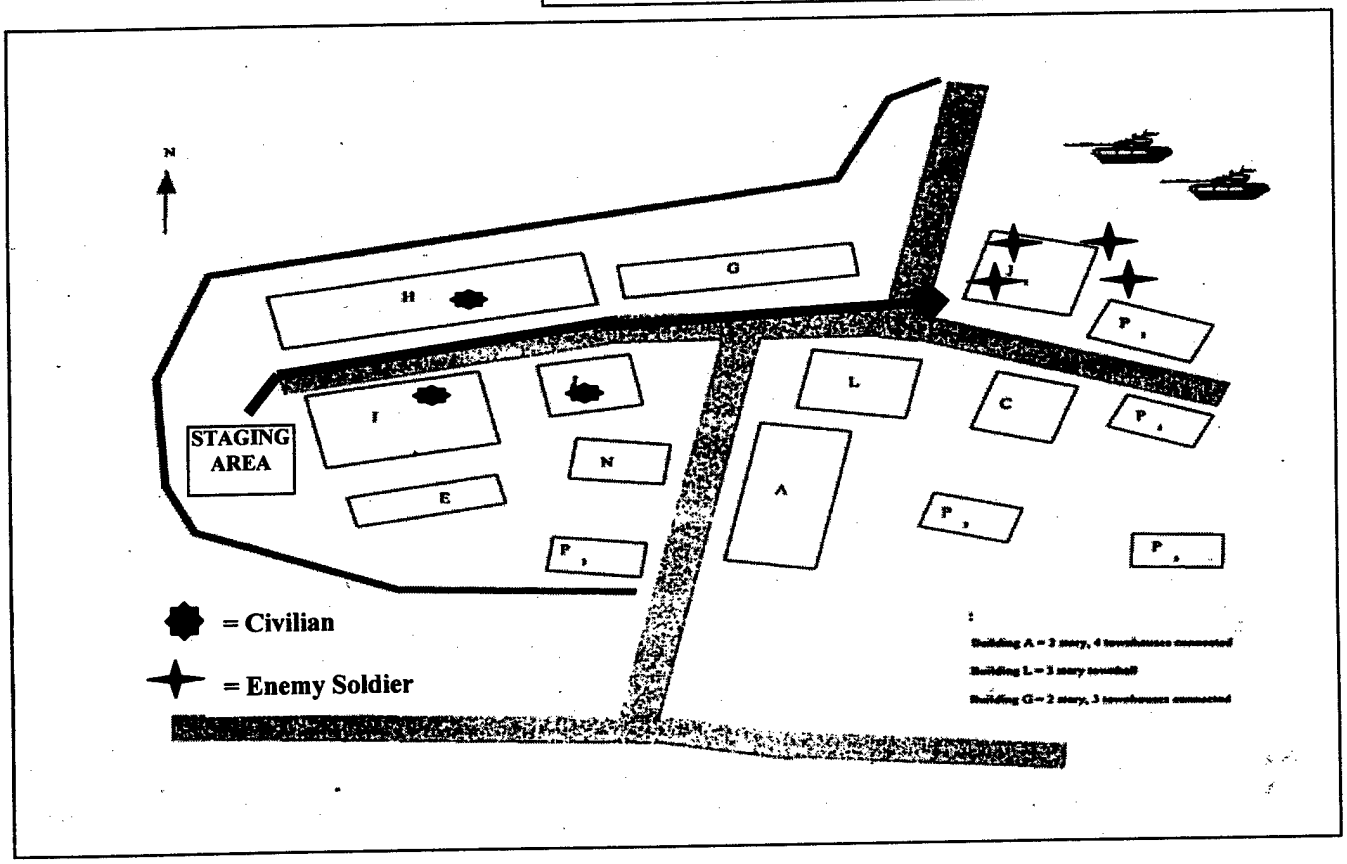
4. Could soldiers accurately identify support positions that would enable fire to be placed on the enemy?

5. Were soldiers able to identify areas that would mask supporting element fires?

Sample Reconnoiter Scenario Map

Vignette #4
Reconnoiter Area
FRAGO/Instructions: Target Building "J-1"

- **Squad leader develops plan, coordinates individual movements of team members.**
- **Two-man team begins at west end of town, proceeds east.**
- **Reconnoiter buildings for enemy, civilians and obstacles.**
- **Identify safe and danger areas, and areas that mask supporting fires.**
- **Provide spot reports to squad leader.**



Appendix H

React to Contact

Team receives FRAGO and general instructions

- Route identified. Move to far opposite end of road crossing several intersections. Soldiers move as a two-man buddy team. Soldiers assigned areas to observe across the street. Scan for enemy, civilians, and obstacles. Team members must use tactically sound movement techniques. Must provide appropriate spot reports to squad leader.

- 2-3 soldiers, 2 in VICs, 1 using Bayonet/Desk top SVS system and serving as squad leader.

- Squad leader develops plan goes over individual responsibilities with each team member.

Team begins movement down street

Note. As a refresher for moving tactically, the first part of 'Move through Built-Up Area' scenario with accompanying performance measures can be used. Or, can have soldiers move without assessing tactical movement and focus on react to contact part of scenario.

- Soldiers keep distance between themselves, if possible, to 3-5 meters. Soldiers move single file along the side of the of the street, staying close to the buildings.

- When passing windows, the soldier stays below the window level and does nor silhouette himself. Soldier "hugs" the side of the building. (May not be able to "hug" building, and icon may not be capable of moving below window. Soldier may have to verbalize presence of window and that he moved below it).

- Soldiers scan, stay alert for enemy/civilians in windows across the street or in doorways down the street and note obstacles. (Civilians/obstacles will be present). Spot report made.

- Soldier comes to end of block. Soldier verbally indicates awareness that weapon is not extending beyond the corner of the building. Verbalizes correct technique for looking around corner. [Lying flat on ground only exposing his head (at ground level) enough to permit observation].

- Soldiers prepare to cross street

Operational Measures

1. Were soldiers able to maintain their relative positions with each other?

2. Were soldiers able to move in accordance with directions?

3. Did soldiers move single file?

4. Did soldiers acknowledge presence of windows and verbally indicate that they moved below the windows?

5. Did soldiers correctly identify all civilians, and obstacles?

6. Could they accurately discern the location of these individuals and obstacles?

7. Did soldier stop when he came to the end of a block and verbalize the correct way to look around corner?

8. Did soldier correctly verbalize awareness that his weapon did not extend beyond the corner of the building?

Team receives enemy fire at crossroads

- As team prepares to cross street, enemy begins firing. Soldiers move to nearest covered positions. Begin returning fire immediately. Enemy fire coming from multiple locations (windows, top of buildings, different buildings). Note. SAF OPFOR must not kill everything they see on first sight.

- Fire team leader controls fire using standard fire commands - alert, direction, description, range, method of fire (manipulation and rate of fire) and command to commence firing.

- Fire team member (and fire team leader?) locate sounds, identify flashes of enemy weapons. Indicate location of enemy positions.

- Fire team leader makes a quick assessment of the situation (e.g., identifies size of the enemy, location, obstacles, vulnerable flanks, and covered and concealed flanking routes to the enemy position) and decides on a course of action (e.g., fire and movement, assault, breach, break contact). Fire team leader reports the situation to the squad leader.

Operational Measures

1. Did the fire team leader use the appropriate fire commands?

2. Were team members able to accurately identify enemy positions?

3. Could team members accurately locate the enemy from weapon flashes?

4. Could team members accurately locate the enemy from the sounds of their weapons?

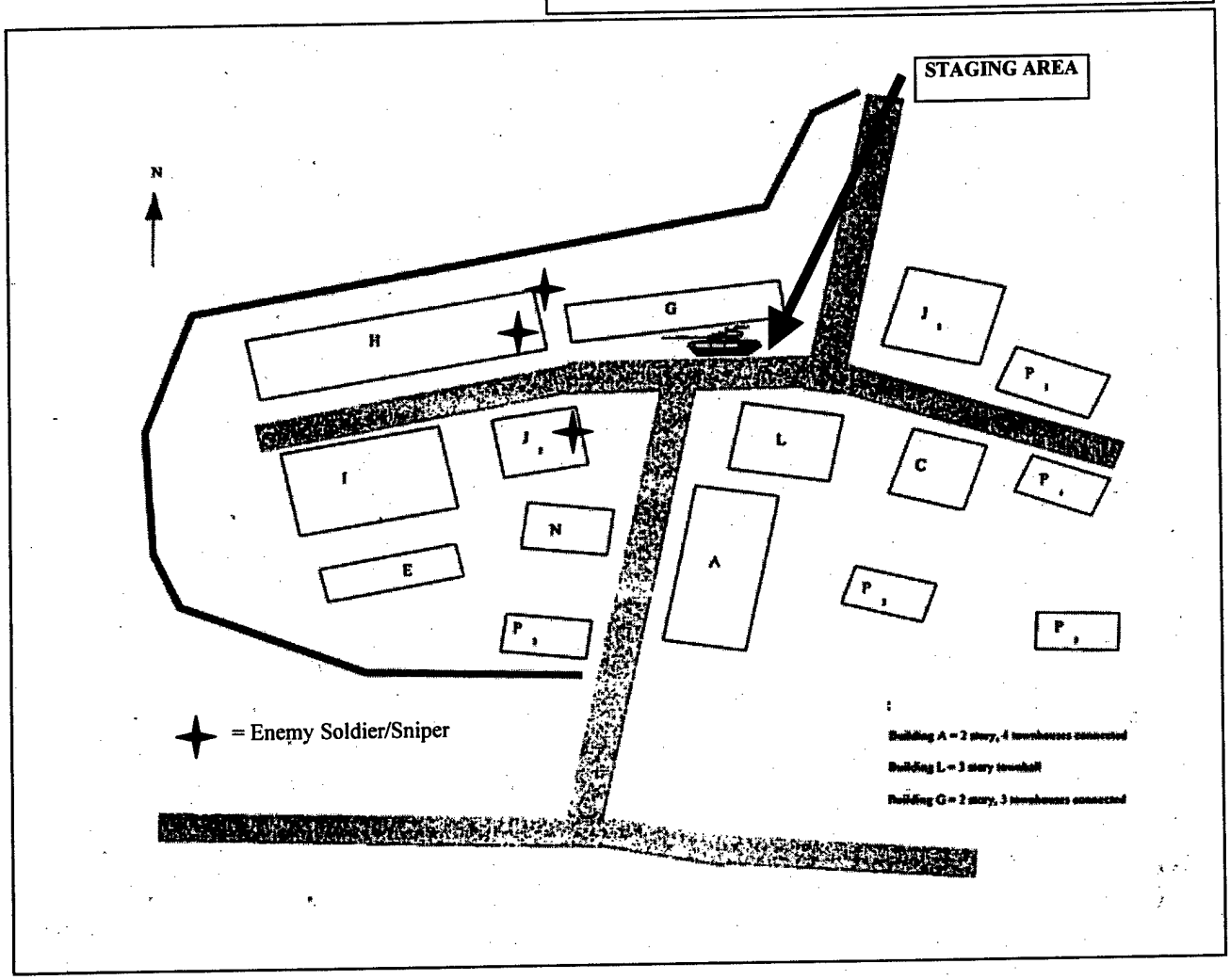
5. Could the fire team leader accurately assess the situation in terms of enemy size, location, identification of vulnerable flanks and covered and concealed routes to the enemy position?

6. Was an appropriate course of action determined?

Sample React to Contact Scenario Map

Vignette #7
React To Contact:
FRAGO/Instructions:

- **Squad leader develops plan, coordinates individual responsibilities of team members.**
- **Two-man team begins at north end of town, proceeds south, moving tactically.**
- **Scan and stay alert for possible enemy, civilians, and obstacles.**
- **Identify safe and danger areas, and areas that mask supporting fires.**
- **Provide appropriate reports to squad leader.**



Appendix H

Assault

Team receives FRAGO and general instructions

- Small element (fire team) occupies key building (partial building) or area with trees and obstacles (e.g., burned out vehicles) at end of block (or at the edge of town). Squad is directed to attack the enemy. Squad leader, with input from fire team leader and fire team member, identifies covered and concealed route. Squad leader identifies support position which will enable fire to be placed on the enemy. Identifies areas that mask supporting fires. Identifies firing positions in area. Identifies safe and danger areas. Soldiers must use tactically sound movement techniques. Must provide appropriate spot reports to squad leader.

- 2-3 soldiers, 2 in VICs, acting as fire team leader and fire team member, 1 using Bayonet/ Desk top SVS system serving as squad leader.

- 5 DI-SAF soldiers to provide fire support.

- Squad leader develops plan with fire team leader and fire team member.

Operational Measures

1. Was a plan developed?
2. Were support positions identified?
3. Were areas that might mask supporting fires identified?
4. Were firing positions identified?
5. Were safe and danger areas identified?
6. Was a covered and concealed route identified?

Team begins movement

- Team moves using covered and concealed route, applying tactically sound movement techniques. (See 'Move through Built-Up Area'). Can focus on specific movement behaviors or just note general movement pattern and concentrate on assault part of the scenario. Fire team leader provides spot reports as necessary and responds to squad leader's commands in route to objective.

- DI SAF fire support is pre-positioned based on squad leader's judgment (and feedback from fire team leader and fire team member).

- When fire team leader and fire team member arrive at objective (last covered and concealed position before the assault), fire team leader reports to squad leader.

Operational Measures

1. Did fire team leader provide all information requested by the squad leader?

2. Did the fire team leader provide a spot report once his team arrived at their position prior to the assault?

Squad performs the Assault

- The squad leader insures all elements are in position. He controls suppressive fires.
- The assault element (team) delivers a heavy volume of fire while assaulting the objective.
- Assault element moves (as best as simulation will allow), using cover and concealment where available as they move across objective.
- Assault focus is a narrow sector of the enemy's defense if flank is not available.
- SAF OPFOR returns fire decisively and attempts to fix unit. (Note. SAF OPFOR and BLUFFOR must not kill everything they see on the first shot).
- Assault element secures (attempts to secure) the objective. Fire team leader provides spot report.
- Squad leader gives order for the support element to move to the objective.
- Squad consolidates and reorganizes.

Operational Measures

1. Did squad leader check to see that all elements were in position?

2. Did the squad leader effectively control suppressive fires?

3. Did the assault element deliver a heavy volume of fire at directed areas of objective?

4. Was the assault element able to secure the objective?

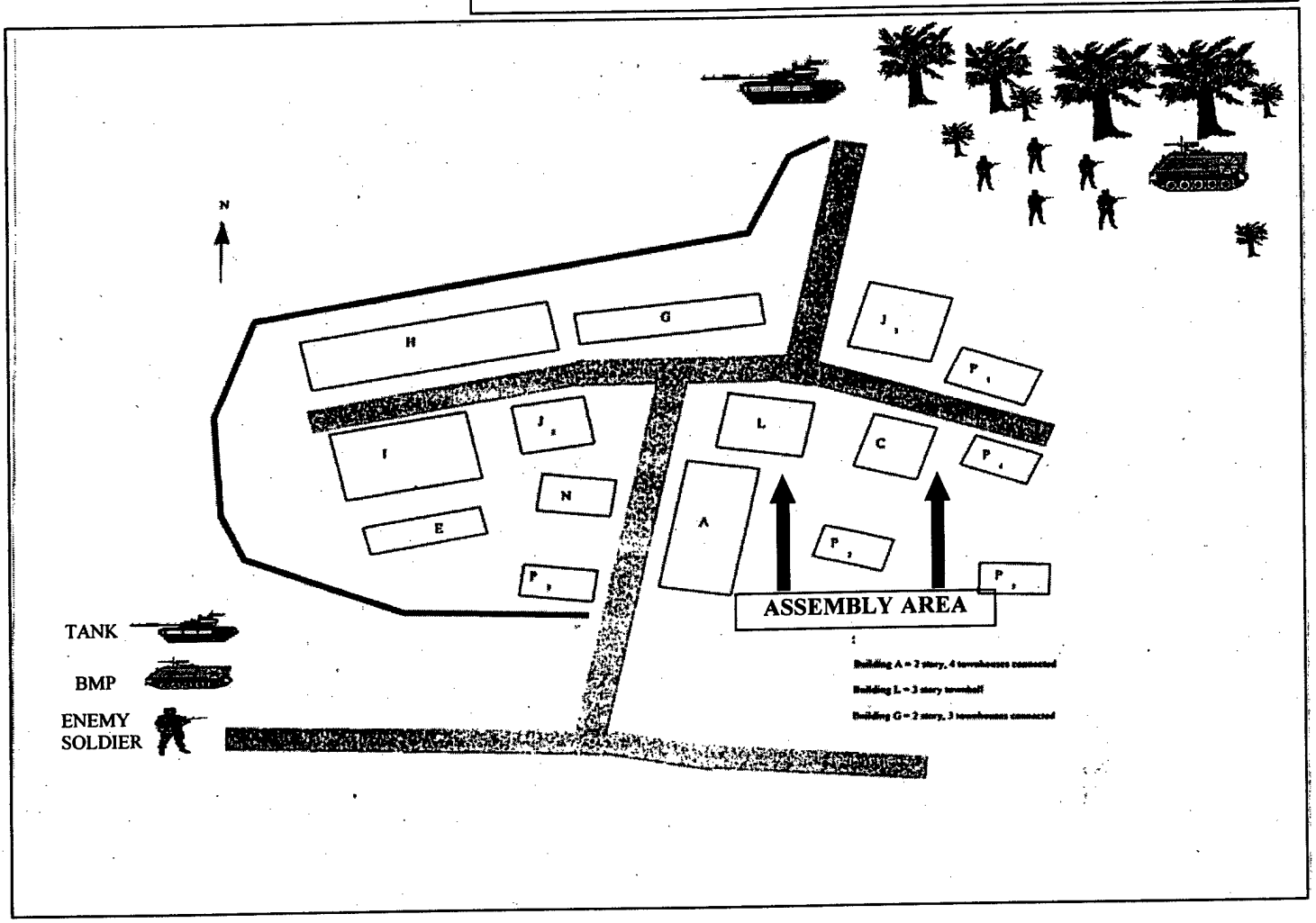
5. Did the fire team leader provide a spot report?

6. Did the squad leader give the order for the support element to move to the objective?

Sample Assault Scenario Map

Vignette #10
Assault: Squad to attack small element occupying tree line northeast of town.

- **Squad leader develops plan with team leaders.**
- **Squad leader, with input from team leaders, identifies covered and concealed route.**
- **Squad leader identifies support positions, safe and danger areas, and areas that mask supporting fires.**
- **Squad executes assault as planned. Provides appropriate spot reports to squad leader.**



Appendix H

Clear Building

Team receives FRAGO and general instructions

- Building specified; one or more enemy in building; one or more civilians/hostages may be in building. Clear building (number of rooms to be determined) without taking civilian casualties. Must come through door. Team members verbally acknowledge use of grenades (none will be available to actually use), must use tactically sound movement pattern(s) within room(s), identify and demonstrate appropriate sectors of fire and use appropriate verbal commands. Must provide appropriate spot reports to squad leader.

- 2-4 soldiers, 2 in VICs, 1 using Bayonet/Desk top SVS system and serving as squad leader. Fourth man may serve as security element outside of building.

- Squad leader develops plan, goes over individual responsibilities with each team member.

Team positioned outside of door

- Team members must be positioned close to one side of the doorway (not standing in the open door frame). If unable to physically do this they should be able to verbalize their location by the door. Verbally acknowledge check for booby traps around door. [Weapons held in either the high-carry (outside the door) or low-carry position (while inside the room). Soldiers ensure the muzzle is not pointed at another team member. Close Quarters Combat, Appendix K, FM 90-10-1].

- Door assumed to be opened (by automatic fire). The first soldier indicates that grenade is thrown in the room (grenade cooked down two seconds prior to throwing) by yelling **"Frag out"**.

Operational Measures

1. Positioning of team members (Were they positioned to the side of the door or did they state what position they would be in at the door if the VIC did not allow them to physically to position themselves correctly?)

2. Was a check made or was verbal acknowledgement given about checking for booby traps around the door?

3. Were weapons held appropriately prior to entering the room? Were they held appropriately while inside the room? Was position of the muzzle pointed away from other team members?

4. Did team members signal (non-verbal) one another that they were ready prior to entering the room?
5. Was appropriate verbal command given prior to throwing grenade (or verbally indicating that grenade was thrown) in the room?

Team enters room

- Second man immediately enters room and positions himself to the left (right) of the entrance against the wall; engages targets with short bursts of automatic fire; scans room left to right. Moves in as straight line as possible toward the left (right) corner. He may then turn and move deep into the far corner of the room. **[For close quarters combat, the emphasis appears to be for the entire team to enter as quickly as possible and clear the doorway. Is this a different approach from the one described below in FM 90-10-1 where soldiers appear to come in the room one at a time?** This approach is more deliberate and slower, it seems, than the one described in Close Quarters Combat, Appendix K, FM 90-10-1].

- First man in room (soldier 2) decides where the next man should position himself and gives the command "**Next man in, right (left)**".

- The next man shouts "**Coming in, right (left)**", enters the room, and positions himself up against the wall right (left) of the entrance and scans (right to left) the room. [Enters and moves toward the corner in the opposite direction, following the wall, but not directly against it. Engages targets as he moves to his designated point. Close Quarters Combat, Appendix K, FM 90-10-1].

Note. With the standard four-man team mix for clearing rooms, the Number 3 man (team leader) would then enter the room next, and buttonhooks inside the room at least one meter from the door, but between the number 1 man (first man in) and the door. The squad leader can either use the number 4 man (normally the SAW gunner) as rear security at the breach site or door, or can have him enter with the remainder of the team. If he enters, the number 4 man moves in the direction of the second man in the room and buttonhooks in the same way between the second man and the door [Close Quarters Combat, Appendix K, FM 90-10-1].

- Each clearing team member must know his sector of fire and how his sector of fire overlaps and links with the sectors of the other team members. While team members move toward their points of domination, they engage all targets in their sector. Team members must be able to discriminate between hostile and non-combatant occupants in the room . [Close Quarters Combat, Appendix K, FM 90-10-1].

Operational Measures

1. Did the soldier enter and move inside the room in a tactically sound manner?

2. Did the soldier scan his area and engage targets with short bursts of automatic fire?

3. Did the soldier use appropriate verbal commands to direct the next soldier into the room?
4. Did the soldier use the appropriate verbal response prior to entering the room?
5. Were soldiers aware of their assigned sectors of fire?
6. Did soldiers engage all targets in their sector?
7. Did they correctly discriminate between hostile and non-combatant occupants in the room?

Room has been cleared

- Once a room has been cleared, team yells "**Clear**" to inform the support party. Before leaving the room and rejoining the support party, team yells "**Coming out**" and proceeds to clear the next room(s). The cleared rooms are marked IAW unit SOP.
- Spot report made back to the squad leader (key points for inclusion in the report should be…enemy casualties (wounded or dead), friendly casualties (wounded or dead), civilians/hostages (wounded or dead), results from room search.

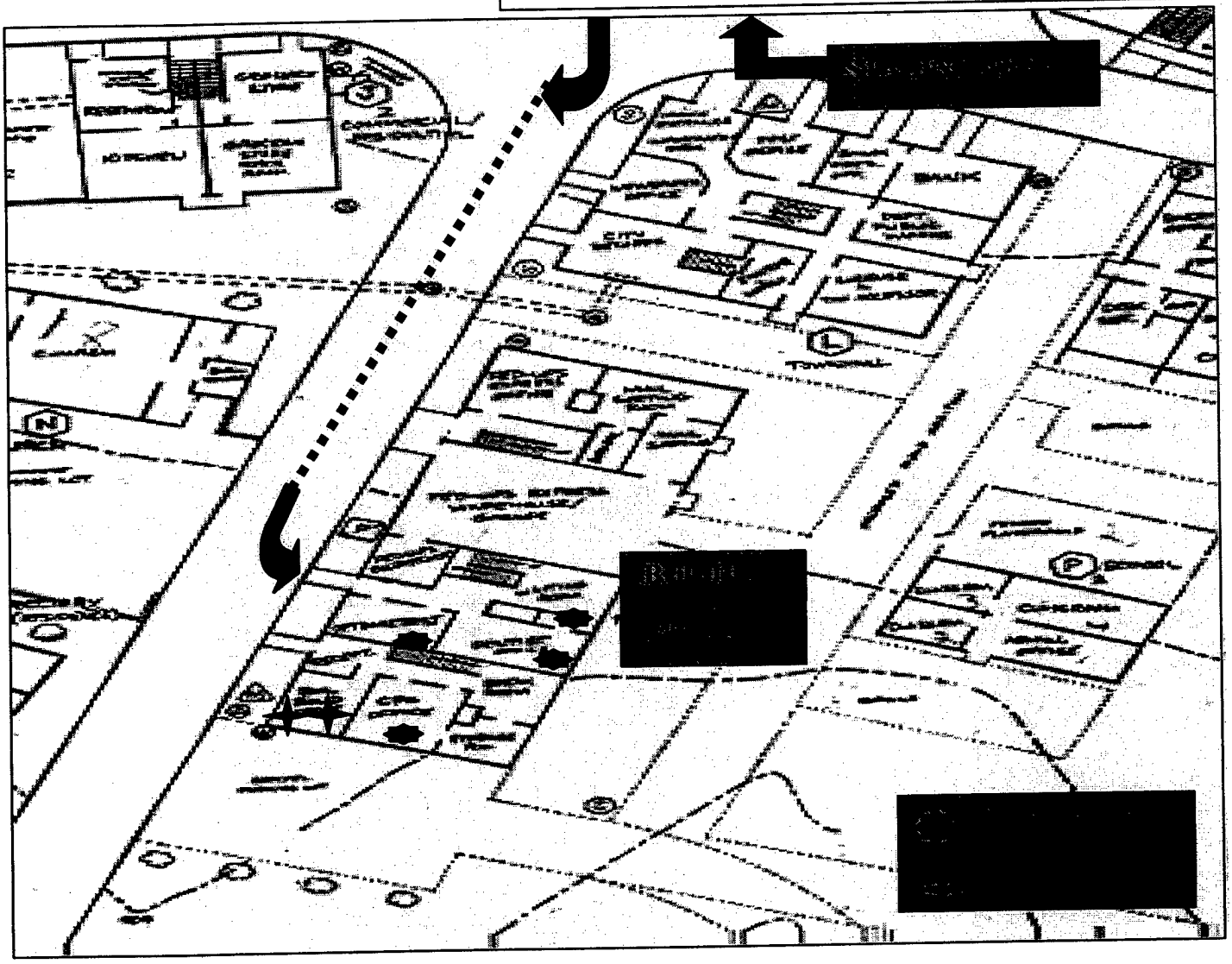
Operational Measures

1. Did the soldier use appropriate verbal responses following the clearing of a room and prior to leaving the room?
2. Did the soldier indicate that room had been marked?
3. Was a spot report made? Were all relevant pieces of information included in the report?

Sample Clear Building Scenario Map

Vignette #15
Clear Building: Enemy and/or civilians may be present in any room on first and/or second floor.
FRAGO/Instructions: Approach from north. Enter second door of Building "A".

- **Squad develops plan with team leader, coordinates individual responsibilities of team members.**
- **Enter building, search and clear room to room without causing civilian casualties.**
- **Employ tactically sound techniques, verbally indicate use of grenades, use appropriate verbal commands.**
- **Provide appropriate spot reports to squad leader.**



Appendix I

Post Experiment Questionnaire

Name:_____ Date:_____

1. Which scenarios do you think provided the most training value?
(Check as many as appropriate)

_____Clear building (with snipers)
_____Clear building (with crossfire)
_____Clear building (with OPFOR following BLUFOR in building)
_____Clear building (with force on force)
_____React to contact
_____React to contact (with force on force)
_____Combination DI-SAF/live squad missions

Briefly explain why you selected these particular scenarios.

2. What other tasks (e.g., assault, ambush) could be cost effectively trained using simulations?

3. Which scenarios did you prefer the most (check the category below)

_____Scenarios involving DI-SAF only

_____Scenarios involving some combination of live force on force with some DI-SAF

Briefly explain your answer.

4. To be effective from a training standpoint, what capabilities should DI-SAF have?

5. For small unit (squad, fire team) level training, what points (e.g., communication, team coordination) should be stressed in these scenarios?

6. As a small unit leader, what did you like most about the scenarios?

7. As a small unit leader, what did you like least about the scenarios?

8. Could these scenarios be used effectively to practice decision making skills? Why or Why not?

9. Would you like to see some type of feedback feature following the completion of each scenario such as number of OPFOR-BLUFOR killed/wounded, rounds fired by soldier, movement patterns of soldiers, etc. ?

_____Yes
_____No

10. What type of feedback would you find most useful?